

RECEIVED

MAR 04 2003

DIV. OF OIL, GAS & MINING

**EVALUATION OF
MINE-WATER DISCHARGE IMPACTS IN
ECCLES CREEK AND MUD CREEK**

**CANYON FUEL COMPANY
Skyline Mine
Scofield, Utah**

December 2002

Prepared by

EARTHFAX ENGINEERING, INC.
Engineers/Scientists
Midvale, Utah



TABLE OF CONTENTS

<u>Section</u>	<u>Page</u>
1.0 INTRODUCTION	1-1
2.0 FIELD DATA METHODS	2-1
2.1 Establish and Characterize Reference Sites	2-1
2.2 Determine Depth to Groundwater	2-3
2.3 Gather Available USGS Flow Data	2-4
2.4 Gather and Evaluate Historic Aerial Photographs	2-4
2.5 Collect Additional Water-Quality Data	2-5
2.6 Evaluate Bank Stability Indexes	2-5
2.7 Long-Term Monitoring	2-6
3.0 DATA RESULTS	3-1
3.1 Characterize Reference Sites	3-1
3.2 Determine Depth to Groundwater	3-2
3.3 Available USGS Flow Data	3-4
3.4 Evaluate Historic Aerial Photographs	3-4
3.5 Additional Water-Quality Data	3-5
3.6 Evaluate Bank Stability Indexes	3-6
3.7 Geotechnical Data and Analyses	3-8
4.0 REFERENCES	4-1

LIST OF FIGURES

<u>Figure</u>	<u>Page</u>
Figure 2-1. Location of Reference Sites	2-8
Figure 3-1. USGS Eccles Creek Streamflow Record	3-19
Figure 3-2. USGS Mud Creek Streamflow Record	3-20

LIST OF TABLES

<u>Table</u>	<u>Page</u>
Table 2-1. Benchmark GPS Coordinates	2-7
Table 3-1. Reference Sites Channel Dimensions	3-10
Table 3-2. Reference Sites Flow Measurements	3-11
Table 3-3. Piezometer Details	3-12
Table 3-4. Water Quality Loading Estimates	3-13
Table 3-5. Bank Erosion Hazard Input Data	3-14
Table 3-6. Bank Erodibility Hazard Rating Evaluation - Eccles and Mud Creeks	3-15
Table 3-7. Hydraulic Stress Hazard Rating Evaluation - Velocity Gradient Rating	3-16
Table 3-8. Hydraulic Stress Hazard Rating Evaluation - Area Rating	3-17
Table 3-9. Hydraulic Stress Hazard Rating Evaluation - Shear Stress Rating	3-18

LIST OF APPENDICES

Appendix

- A Photographs of Reference Sites
- B Reproduction of Field Log Books
- C Channel Bed and Bank Sample Data
- D Water Quality Data Sheets
- E Channel Cross-section and Profile Plots
- F Streamflow Data Tabulations
- G Aerial Photographs
- H Erosional Stability Analyses
- I Geotechnical Stability Analyses

**EVALUATION OF
MINE-WATER DISCHARGE IMPACTS IN
ECCLES CREEK AND MUD CREEK**

1.0 INTRODUCTION

In early August 2001, a fractured sandstone aquifer was encountered in the Skyline Mine, resulting in a significant inflow of groundwater to the mine. In an effort to minimize environmental impacts and meet effluent limitations, much of the water encountered was initially pumped to inactive sections of the mine for temporary storage.

It was assumed that the water encountered would have a high inflow for a short duration and then decrease with time, as frequently occurs in the area. However, rather than decreasing significantly with time, the inflow has only slightly diminished over time. Once available underground areas for water storage were filled, the mine began pumping both the inflow water and the stored water to the surface to prevent mine flooding and allow continued operation. Since early September 2001 discharges from the mine to Eccles Creek ranged between about 10,000 and 15,000 gallons per minute ("gpm"), compared with an average discharge for the prior 18 months of about 4,000 gpm.

On October 11, 2001, EarthFax Engineering, Inc. conducted a reconnaissance geomorphic evaluation of Eccles Creek to assess potential impacts of the discharge on the stability of the stream channel. The results of this evaluation were combined with an assessment of potential water-quality impacts in a letter report to Canyon Fuel Company dated October 24, 2001. Additional information regarding potential impacts to phosphorus concentrations was provided on December 3, 2001 and December 13, 2001.

On November 26, 2001, EarthFax conducted a more extensive field evaluation of the impacts of mine-water discharges on Eccles and Mud Creeks. Samples of the bed and bank materials were collected to allow an assessment of the structural and erosional stability of the stream channels. In addition, subsequent analyses were conducted to determine the potential effects of mine-water discharges on peak annual flows in the streams and the potential impacts to man-made structures in the streams. An evaluation of alternative discharge points was also conducted. The results of these investigations were presented in a letter report to Canyon Fuel Company on February 27, 2002.

Following a review of the submitted information, Canyon Fuel Company and EarthFax met with representatives of the Utah Division of Oil, Gas and Mining (the "Division") to discuss the results. In these meetings, the Division requested additional information to better quantify and monitor potential impacts to Eccles and Mud Creeks. The objective of gathering this additional information is to:

1. Quantify whether or not increased flows may be causing erosion and/or sediment deposition in quantities that are adverse to the hydrologic regime of Eccles Creek and Mud Creek.
2. Quantify the degree to which the increased flows may be contributing to sediment and phosphorus loads in Scofield Reservoir.
3. Provide a means for monitoring potential long-term impacts to the morphology of Eccles and Mud Creeks.
4. Quantify whether or not changes are occurring in the elevation of the water table in the alluvial deposits adjacent to Eccles and Mud Creeks due to the increased flows.
5. Collect data to determine whether or not an Alluvial Valley Floor exists adjacent to Mud Creek.

Canyon Fuel Company
Skyline Mine

Mine-Water Discharge Impact
December 2002

6. Quantify whether or not changes are occurring to the vegetation adjacent to the stream corridor due to the increased flows. Also, quantify whether or not vegetative changes occur as a result of the potential future decrease in present discharge rates from the mine.

The purpose of this document is to present the results of the collection of data to address items 1 through 5 above. A separate report will address item 6.

2.0 FIELD DATA COLLECTION METHODS

2.1 Establish and Characterize Reference Sites

Reference sites were established on Eccles and Mud Creeks at the locations shown on Figure 2-1. Sites EC-1, 2, and 3 as well as MC-1, 2, and 3 correspond to cross section locations used in previous investigations (EarthFax Engineering, 2002). Sites MC-4, MC-5, and MC-6 were established to evaluate conditions on Mud Creek within a section of agricultural pasture (MC-4 and MC-6) and upstream from the Eccles Creek confluence (MC-5). A portion of the Mud Creek flows are diverted upstream of MC-4 for flood irrigation purposes in an extensive area near MC-4. As a result, the water table is artificially high at MC-4 and not representative of natural subirrigation that might occur in Pleasant Valley. MC-6 was therefore established upstream from the diversion to serve as a monitoring point in an area not affected by flood irrigation.

All reference sites were established in general conformance to the recommendations of Harrelson et al. (1994). The work at each site involved the following:

- Establishing benchmarks at each site. Benchmarks were installed by drilling an 8-inch diameter hole to a depth of at least 36-inches using a portable power auger. Each hole was filled with concrete and the monument was identified with a brass marker stamped with the site number. An exception to this method of benchmark establishment occurred at MC-6, where a UDOT benchmark existed at a location convenient to the location. A brass tag was attached to the fence adjacent to this UDOT benchmark to identify the location. Photographs were taken and descriptions provided to allow others to return to the sites in the future. Photographs are presented in Appendix A.

Each benchmark position and elevation was determined in the field using a Trimble TSCe GPS unit. These locations were plotted on the USGS quadrangle

for the area (see Figure 2-1). Table 2-1 presents the coordinates of the benchmarks in both the WGS-84 and NAD-27 coordinate systems.

- Establishing monumented cross sections. The endpoints of cross sections were marked with 4 foot long, 1/2-inch diameter steel reinforcing bars that have been driven approximately 3.5 feet into the ground. The bars were capped with plastic survey end caps marked with the cross-section number.

The locations of the cross section endpoints with respect to the benchmarks were measured, using a tape and Brunton compass or with the GPS unit, with the measurements noted in the field log book (see Appendix B).

- Surveying the channel cross section at each site. A measuring tape was attached to one of the cross section monuments and stretched tight and level across the stream to the other monument. Surveying was performed using a Sokkia survey level and rod. Elevations were shot at each important feature or change in elevation (e.g., slope breaks, channel banks, bankfull stages, etc.). The survey was closed by re-shooting the station benchmark. The readings were recorded in the field log book (see Appendix B).
- Surveying the longitudinal profile at each site. The profiles extend a distance of at least 20 times the channel width (half upstream and half downstream from the cross section location). Data were collected to indicate the elevation of the channel bottom, the water surface, indications of bankfull stage, and the top of the stream bank. Measurements were collected on intervals approximately equal to the channel width. Data were collected using a survey level and rod, with the location of the starting and endpoints being measured as noted above. Data readings were recorded in the field log book (see Appendix B).
- Establishment of photo points. As recommended by Harrelson et al. (1994), convenient locations were selected to take photographs upstream, downstream, and across the channel at each cross section location.
- Collection of streamflow data. The flow was measured at each site, using standard procedures, with a flow meter. The readings were recorded in the field book (see Appendix B).

Samples of the bed and bank materials were collected at the newly established stations (MC-4, MC-5, and MC-6) to evaluate geomorphic and stability relationships at those locations. Similar samples were collected in February 2002 at the sites EC-1 through EC-3 and MC-1 through MC-3 (EarthFax Engineering, 2002) and are still considered valid. These samples consisted of a combination of shelby tubes and grab samples for gradation, bulk specific gravity, soil moisture, void ratio, and shear testing (see Appendix C for data).

2.2 Determine Depth to Groundwater

The depth to groundwater was determined at each of the reference sites on Mud Creek. This was accomplished by installing temporary piezometers in the alluvium on each side of the stream. The locations of the piezometers were sited in an attempt to determine the slope of the water table perpendicular to the stream channel at each reference site. At reference sites MC-4 and MC-6, multiple piezometers were installed on each side of the creek. Due to the limited width of the valley or the accessible area, cross-sections MC-1, MC-3, and MC-5 had room for only one piezometer to be installed on each side of the creek. Cross-section MC-2 had room for two piezometers on both sides of the creek; however, three attempts to advance the borehole and install a second piezometer on the west side of the creek encountered refusal above the water table and were unsuccessful. Therefore, efforts were abandoned at this location.

The piezometers were installed using a 3-inch diameter portable flighted auger and a hammer drill to advanced each borehole to a depth where cuttings were saturated. Then a 3/4-inch diameter PVC pipe was installed in each borehole. The bottom 2 feet of pipe in each borehole was perforated with 1/8-inch diameter holes on 1- to 2-inch centers. Any excess pipe was cut off, leaving a 3- to 6-inches sticking up above the ground surface.

The water table was allowed to stabilize for a period of one week prior to measuring the depth to water in the boreholes. Water levels were obtained using a Slope Indicator 100 water level meter. Depth to water measurements were obtained from the top of casing.

The location and elevation of the piezometers were established by standard surveying techniques from the previously-established benchmark at each site. The locations were determined by distance and bearing measurements for those piezometers which were close to the benchmarks and by GPS for those which were located a substantial distance from the benchmark. Piezometers for reference sites MC-3, MC-4, and MC-6 were located using GPS.

Elevations of the piezometers were determined using a Sokkia level and stadia rod. The relative elevation of the benchmark and the top of casing and ground surface were determined.

2.3 Gather Available USGS Flow Data

Flow data on file with the U.S. Geological Survey were gathered for Eccles Creek near Scofield, Utah (station 09310600) and for Mud Creek below Winter Quarters Canyon at Scofield, Utah (station 09310700). These data are available electronically from the U.S. Geological Survey online database (http://waterdata.usgs.gov/nwis/discharge/?site_no=09310600 and http://waterdata.usgs.gov/nwis/discharge/?site_no=09310700).

2.4 Gather and Evaluate Historic Aerial Photographs

Historic aerial photographs were gathered of Pleasant Valley between the town of Scofield and the confluence of Mud Creek and Eccles Creeks. Both private sources (on file with aerial photography companies) and government sources (USDA, USGS, EROS) were searched. Very limited coverage in the Pleasant Valley area was available from private companies,

generally on the ridges adjacent to the valley and none on the valley bottom. The USDA had aerial coverage for the years 1962, 1980, 1987, 1993, and 1997. These photographs were evaluated to assess historic land use in this reach of Pleasant Valley.

2.5 Collect Additional Water-Quality Data

Water-quality samples were collected by Canyon Fuel personnel at monitoring points MC-1 through MC-5. In addition to the collection of flow data as indicated in Section 2.1, these samples were analyzed for total dissolved solids (TDS), total suspended solids (TSS), and total phosphorus. Appendix D presents the data sheets on the analyses of the samples collected.

2.6 Evaluate Bank Stability Indexes

Data were gathered to determine the bank erodibility hazard (Rosgen, 1996; 2001) for each reference site. The data collected included measurements of the following values:

- Bank height
- Bankfull depth
- Rooting depth
- Root density
- Bank slopes
- Degree of surface protection of the bank

The in-stream velocity gradient (between the core of maximum velocity and the stream bank) and the ratio of average hydraulic stress and near-bank hydraulic stress were calculated. These indexes are compared with typical values provided by Rosgen (1996; 2001) to provide another assessment of bank stability in addition to estimates provided previously (EarthFax Engineering, 2002).

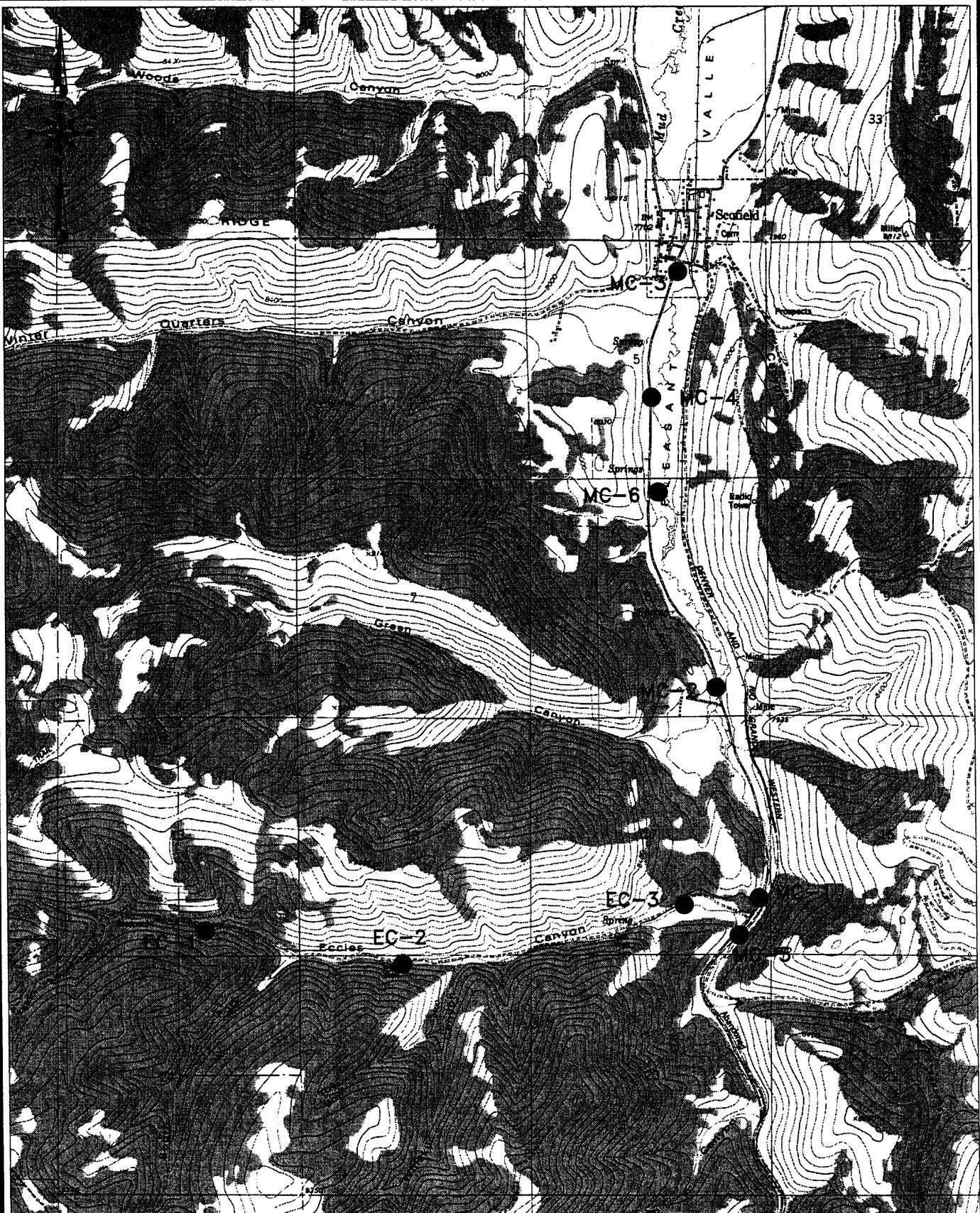
2.7 Long-Term Monitoring

Flow and water-quality data (TDS, TSS, total phosphorus) will be collected at monitoring points MC-1 through MC-5 four times per year (i.e., seasonally), when accessible, for a period of one year following a sustained reduction in mine-water discharge to a rate of 350 gpm or less (i.e., pre-March 1999 levels). Average sediment yield contributions to Scofield Reservoir will be calculated from the TSS and flow data. Channel cross sections and longitudinal profiles will be collected from each reference site annually during the same period. Flow and water-quality data will also be collected any time there is an increase in discharge rates from the mine of at least 25% above the average rate for the prior month.

TABLE 2-1

BENCHMARK GPS COORDINATES

ID ^(a)	Elev. (ft)	WGS-84 Datum (Typical Default Field GPS Reading)				NAD-27 Datum (USGS Map Coordinate)			
		Latitude (N)	Longitude (W)	UTM Easting (m)	UTM Northing (m)	Latitude (N)	Longitude (W)	UTM Easting (m)	UTM Northing (m)
EC-1	8499.13	39° 41' 2.8"	111° 11' 52.3"	483033	4392717	39° 41' 2.9"	111° 11' 49.7"	483094	4392509
EC-2	8257.72	39° 40' 54.9"	111° 10' 56.3"	484365	4392471	39° 40' 55.0"	111° 10' 53.7"	484428	4392263
EC-3	7971.59	39° 41' 7.2"	111° 09' 36.6"	486264	4392844	39° 41' 7.3"	111° 09' 34.0"	486327	4392639
MC-1	7898.53	39° 41' 10.2"	111° 09' 02.0"	486750	4392937	39° 41' 10.3"	111° 09' 13.6"	486813	4392730
MC-2	7827.04	39° 41' 56.7"	111° 09' 27.9"	486476	4394370	39° 41' 56.8"	111° 09' 25.3"	486537	4394164
MC-3	7698.23	39° 43' 27.1"	111° 09' 37.1"	486262	4397159	39° 43' 27.2"	111° 09' 34.5"	486323	4396952
MC-4	7728.64	39° 43' 0.3"	111° 09' 47.1"	486023	4396331	39° 43' 0.4"	111° 09' 44.5"	486083	4396126
MC-5	7915.35	39° 41' 2.4"	111° 09' 21.2"	486633	4392697	39° 41' 2.5"	111° 09' 18.6"	486693	4392490
MC-6	7763.84	39° 42' 38.9"	111° 09' 47.0"	486022	4395673	39° 42' 39.0"	111° 09' 44.4"	486084	4395466



BASE MAP: USGS 7-1/2 MIN. QUADRANGLE
SCOFIELD, UTAH (1979)

0' 3000'



FIGURE 2-1. LOCATION OF REFERENCE SITES

3.0 RESULTS SUMMARY

3.1 Characterize Reference Sites

As described in Section 2.1, the reference sites were established on Eccles and Mud Creeks at the locations shown on Figure 2-1. Photographs were taken and are presented in Appendix A.

Surveys of the channel cross section and longitudinal profile were conducted at each site. Data collected from the channel cross sections and profiles of the channel bottom, the water surface, indications of bankfull stage, and the top of the stream bank are presented in copies of the field book in Appendix B and in cross section and profile plots in Appendix E. Table 3-1 presents a summary of the channel dimensions and slopes for each reference site.

As can be seen from the average values presented in Table 3-1, the slope of Eccles Creek is considerably steeper than Mud Creek. Also, the Eccles Creek channel sideslopes are generally steeper and have a greater height than the Mud Creek channel. There are portions of the Mud Creek channel which have similar steep sideslopes, but these reaches tend to be limited in extent.

Streamflow data were measured at each site except MC-6, using standard procedures, with a rotating-cup flow meter. The field measurements are presented in Appendix B. Table 3-2 presents the flow data measured at each reference site. Station MC-6 was not established as a permanent reference site until approximately three months after establishment of the other sites, at the request of the Division. Given the time lapse, flow data would not be comparable and the decision was made to not collect flow data at this location.

As indicated in Table 3-2, the flow in Eccles Creek generally increases in the downstream direction. Near the confluence of Eccles Canyon and Mud Creek, the flow in Mud Creek at MC-1 on August 27, 2002 was only 62% of the sum of the components (as measured in Eccles Creek at EC-3 and in Mud Creek at MC-5). This decrease is likely due to a loss of surface flow to the coarse-grained alluvium in the area. As the gradient changes from the relatively steep grade for Eccles Creek to the relatively gentle grade for Mud Creek, as indicated in Table 3-1, the coarser bed load was rapidly deposited. This resulted in the stream bed and banks near the mouth of Eccles Creek being composed of very porous materials with high permeability. Thus, as the surface flow crosses the more permeable materials, the stream flow diminishes and the "lost" water is carried in the alluvial deposits adjacent to the channel. In the reach downstream of this area, toward MC-2 where the channel deposits are less permeable, the majority of the alluvial subsurface flows return to the stream channel.

Below MC-6, the flows in Mud Creek are diverted for irrigation. Approximately 10 cfs is removed from the creek flow. Thus, the flow reported at MC-4 is significantly lower than at MC-2. The majority of irrigation returns occur in the reach between MC-4 and MC-3. Therefore, the flows at MC-3 are representative of the majority of surface flow in the lower portion of Pleasant Valley.

3.2 Determine Depth to Groundwater

The depth to groundwater was determined at each of the reference sites on Mud Creek as described in Section 2.2 of this report. Table 3-3 presents the piezometer depths and ground surface and water level elevations.

The water level elevation data were placed on the channel cross-sections presented in Appendix E to aid in determining the relationship between the surface and groundwater

elevations. In the upper reaches of Mud Creek (i.e., cross-section locations MC-5, MC-1 and MC-2, see Attachment E), the piezometer water levels show different conditions at the reference sites. At MC-5, the piezometer water levels are higher than the water in the stream indicating that the groundwater flow is toward the creek. At MC-1 and MC-2, the piezometer water levels are different on both sides of the channel indicating that the groundwater is flowing across the canyon from areas of high water levels on the east of the channel to areas of lower water levels on the west of channel. The elevated groundwater on the east side of the channel may be influenced by the water loss from the stream channel at the mouth of Eccles Canyon or it may indicate recharge to the valley from the east..

For the lower reaches of Mud Creek (i.e., cross-section locations MC-3, MC-4 , and MC-6, see Attachment E), the piezometer water levels on both sides of the stream are higher than the water surface in the stream. Under such conditions, the groundwater flow direction is toward the stream and the stream is said to be gaining. Given the steep slope of the valley bottom toward the stream and the associated relatively steep slopes of the groundwater surface toward the stream, any increase in the water surface of the stream will only raise the potentiometric surface beneath the valley within a relatively small zone adjacent to the stream. **Thus, there is no significant potential for the combined base and mine water flow in the stream channel to increase the groundwater table under a substantial portion of the pastures.**

Utilizing the US Geological Survey stream flow data (Appendix F), the base flow contribution to Mud Creek was estimated. Using the fall and winter data for the early portion of the flow record, before significant mining activity and discharge occurred (i.e., 1978 through 1981), the base flow for Mud Creek was estimated to range between 1.6 and 5 cfs. The variation in base flow likely occurs due to variations in annual precipitation, with wet years yielding higher base flows.

Based on the flow readings in the stream channel at MC-1 (15.0 cfs) thru MC-3 (22.7 cfs), the stream flow increases in a downstream direction. While there are some interferences with inflows from contributing surface stream flow and irrigation return flows, the major portion of the increase likely represents base flow contributions. The flow difference between MC-1 and MC-3 is 7.7 cfs. Assuming that approximately 2 to 3 cfs is contributed from the side drainages, the base flow contribution would be on the order of 3 to 5 cfs. This falls in the range estimated from the US Geological Survey records.

3.3 Available USGS Flow Data

Flow data on file with the U.S. Geological Survey were gathered for Eccles Creek near Scofield, Utah (station 09310600) and for Mud Creek below Winter Quarters Canyon at Scofield, Utah (station 09310700). As indicated in Section 2.3, these data are available electronically. Plots of historical records of daily mean flows for both Eccles and Mud Creeks, obtained from these electronic sources, are presented in Figures 3-1 and 3-2, respectively. Average tabulations of the mean daily streamflow values for both Eccles and Mud Creeks for the period of record are provided in Appendix F.

3.4 Evaluate Historic Aerial Photographs

Historic aerial photographs were gathered of Pleasant Valley between the town of Scofield and the confluence of Mud Creek and Eccles Creeks. As indicated in Section 2.4, photos were obtained from the USDA for the years 1962, 1980, 1987, 1993, and 1997. Copies of these photographs are provided in Appendix G. These photographs were evaluated to assess historic land use in this reach of Pleasant Valley.

Based on a review of the aerial photographs, land use in the area of the Pleasant Valley has not changed significantly since 1962. The same areas that are now used for grazing were used for grazing in the early 1960's. The only significant change that could be identified was in the 1980 photograph, when construction activities were visible in and adjacent to Mud Creek in the area of the irrigation diversion structure located between reference sites MC-4 and MC-6.

3.5 Additional Water-Quality Data

Water-quality samples were collected at monitoring points MC-1 through MC-5 on August 15, 2002 and October 17, 2002. In addition to the collection of flow data and field analyses of pH, temperature, turbidity, dissolved oxygen, and specific conductance, these samples were analyzed for total dissolved solids (TDS), total suspended solids (TSS), and total phosphorus. Appendix C presents the water quality data.

Based on the data collected, the results of loading calculations for dissolved solids, suspended solids, and phosphorus at the reference sites on Mud Creek are presented in Table 3-4. Although concentrations of the analyzed constituents in Mud Creek are similar up- and downstream from the confluence with Eccles Creek (compare MC-5 results with other results), the load increases below the confluence with Eccles Creek due to the higher flow.

With the reduced flow for the fall samples, compared to the August data, the suspended solids concentrations and loading were typically lower. An exception to this generality occurred in the October sample at MC-5, where the suspended sediment concentration was significantly higher than the concentration from Eccles Creek (compare concentrations at MC-5 and MC-1). Due to the lower flow at MC-5, the load estimate is similar to the load from the Eccles Creek contribution. Total dissolved solids concentrations in Mud Creek increased in October relative to August. Hem (1985) indicates that such dissolved solids concentration are likely due to an

inverse function of concentration to the rate of discharge. Even though the flow decreased, dissolved solids loading in Mud Creek was higher in October than in August due to the magnitude of the concentration increase.

These sample results represent the conditions on the days sampled and may not be representative of the long term conditions of the water quality. Future water quality samples, collected as outlined in Section 2.7, will be compare to these values to determine if the load carried by the flow is increasing or decreasing.

3.6 Bank Stability Analyses

Bank stability was evaluated in several ways. First, traditional erosive stability was determined through maximum permissible velocity evaluations. Second, the bank erodibility hazard index for each site was determined.

The bank materials along the reaches of Mud Creek that were sampled in this study consist of clays, silty clays, and silty sands. These soils are well vegetated with a combination of natural grasses and willows. Bed materials range in size from sands through cobbles. As indicated in the maximum permissible velocity determinations, presented in Appendix H, the combination of the vegetation and erosion-resistant materials make the channel banks and beds erosional stable under the evaluated flow conditions (5,000 to 30,000 gpm).

The field information gathered to determine the bank erodibility hazard (Rosgen, 1996; 2001) for each reference site is presented in Table 3-5. A summary of the analyses of these data is presented in Table 3-6. Rooting depth and density data in Table 3-5 were obtained from the soil survey of the area (Jensen and Borchert, 1988). All other data in this table were obtained from field measurements conducted for this investigation.

The bank hazard evaluation for the various reference sites indicates that all have a low hazard of bank failure, except EC-1, EC-3, and MC-5. These sites have a moderate hazard of bank failure. The major criterion for these sites being in the moderate category is the ratio of bank height to bankfull depth. In the area of these reference sites, the bank height is relatively high in comparison to the bankfull depth of flow. If the bank height value in the ratio were reduced, these sites would be adjusted to the low hazard category. EarthFax (2002) reached similar conclusions based on different methods.

The hydraulic stress methodology of Rosgen (1996 and 2001) was also applied to the reference sites to provide an alternative assessment of bank stability. This methodology utilizes three indices which include in-stream velocity gradient (between the core of maximum velocity and the stream bank), cross-sectional area ratio of channel to near bank, and the ratio of average hydraulic stress and near-bank hydraulic stress. Tables 3-7, 3-8, and 3-9 presents the results of the individual indices.

These hazard rating results generate conflicting classifications. Based on the velocity criteria, sites EC-1 and EC-3 are in the extreme and moderate hazard categories, respectively, while all other sites are in the very low hazard category. Using the area criteria, all sites except MC-1, are in the low hazard category. The MC-1 site under this criterion is in the moderate hazard category. Based on the stress ratio, all sites fall in a high hazard category.

This evaluation method has had limited usage and scientific peer review. No applicability criteria for the method regarding appropriate ranges in flow rates, bed and bank material gradations, or channel slopes and dimensions are provided. Therefore, it is unknown if the method is applicable to the reference sites and conditions on Eccles and Mud Creeks. Given the widely-varying, conflicting results, it is possible that Rosgen's hydraulic stress methodology is not applicable to this area.

As no specific guidance is given by Rosgen (1996 and 2001) to handle questionable classifications, some weighting based on professional judgement was applied to this evaluation. These judgements are based on site reconnaissance, prior stability evaluations (EarthFax, 2002), and more than 1 year of continuous duration elevated flows without significant bank failure. Of the criteria used in the stress evaluation, the velocity gradient and area ratio may be the major controlling criteria. Where there is a small distance between high velocity water and the bank, then there is a high potential for erosion to occur. Based on these criteria and the observed conditions, sites EC-1 and EC-3 are classified as moderate hazard sites. All other sites are classified as low erosion hazard.

The evaluations conducted generally show that there is a low hazard of bank failure as a result of the increased flow within Mud Creek. Other factors such as land use activities can also have an affect on bank stability. These activities are only marginally covered through vegetation cover estimates in the evaluation methods. For the sites selected, vegetation cover was good; however, several areas within the pasture, north of MC-4, shows signs of excessive grazing.

3.7 Geotechnical Data and Analyses

Samples of the bed and bank materials were collected at the newly established stations (MC-4, MC-5, and MC-6) to evaluate geomorphic and stability relationships at those locations. Similar samples were collected in February 2002 at the sites EC-1 through EC-3 and MC-1 through MC-3 (EarthFax Engineering, 2002) and are still considered valid. Appendix C presents the data collected for these samples.

These data were evaluated to determine the stability of the stream banks using standard geotechnical evaluations. The results of the studies addressing EC-1 through EC-3 and MC-1 through MC-3 were discussed in the EarthFax report (2002). EarthFax concluded that the

alluvial banks of Eccles Creek and Mud Creek are stable. Similar studies were conducted as part of this report for sites MC-4, MC-5, and MC-6. The results of these evaluations are presented in Appendix I. The banks at these sites were also found to be stable. Safety factors of 6.7, 2.8, and 2.5 were determined for sites MC-4, MC-5, and MC-6, respectively. Generally, a safety factor in excess of 1.3 is considered stable. Considering these results and the conservative analytical assumptions used in modeling stability, it is concluded that the stream banks of Mud Creek will maintain their structural stability with the continued discharge of excess water from the Skyline Mine.

TABLE 3-1
REFERENCE SITE CHANNEL DIMENSIONS

SITE I.D.	AVERAGE PROFILE SLOPE (ft/ft)	MAX. CHANNEL SIDESLOPE	
		LEFT* (ft/ft)	RIGHT* (ft/ft)
EC-1	0.061	0.31	11.43
EC-2	0.051	0.84	2.14
EC-3	0.024	1.80	1.19
Average	0.045	0.98	4.92
MC-1	0.007	0.87	0.70
MC-2	0.012	0.62	0.27
MC-3	0.026	1.66	0.70
MC-4	0.007	1.00	3.49
MC-5	0.016	11.43	0.21
MC-6	0.009	0.84	0.51
Average	0.013	2.74	0.98

* Orientation - looking upstream

TABLE 3-2
REFERENCE SITE FLOW MEASUREMENTS

SITE I.D.	MEASURED FLOW (cfs)
EC-1	21.6
EC-2	21.4
EC-3	23.0
MC-1	15.0
MC-2	24.9
MC-3	22.7
MC-4	13.7
MC-5	1.3
MC-6	-

Note: Flow data collected on August 27, 2002.

TABLE 3-3
PIEZOMETER DETAILS

Piezometer I.D.	Ground Surface Elevation	Depth of Casing BGS*	TOC Stick-up AGS**	Depth to Water BTOC***	Water Elevation
PMC-1A	7897.84	5.30	0.25	4.32	7893.77
PMC-1B	7894.76	2.49	0.27	1.84	7893.19
PMC-2A	7829.53	10.00	1.26	8.20	7822.59
PMC-2B	7825.76	<5.0	1.11	5.04	7821.83
PMC-2C	7830.82	10.00	0.84	8.83	7822.83
PMC-3A	7697.95	5.00	0.23	3.56	7694.62
PMC-3B	7697.22	5.00	0.66	3.44	7694.44
PMC-4A	7727.86	4.5	0.41	1.38	7726.89
PMC-4B	7727.60	7.0	0.63	3.62	7724.61
PMC-4C	7727.60	5.5	0.05	3.95	7723.71
PMC-4D	7733.41	5.0	0.46	0.65	7733.22
PMC-4E	7738.05	3.0	0.16	0.93	7737.28
PMC-5A	7913.95	4.25	0.24	2.82	7911.37
PMC-5B	7914.70	5.93	0.30	3.32	7911.68
PMC-6A	7765.08	10.0	0.92	6.23	7759.77
PMC-6B	7761.96	8.5	0.49	6.10	7756.35
PMC-6C	7761.73	9.0	0.43	7.09	7755.07
PMC-6D	7761.77	7.5	0.48	>7.25	7755.00

* Below ground surface

** Above ground surface

*** Below top of casing

TABLE 3-4
WATER QUALITY LOADING ESTIMATES

Sample Site	Sample Date	Flow (cfs)	Phosphorous		Total Suspended Solids		Total Dissolved Solids	
			(mg/l)	(lb/day)	(mg/l)	(lb/day)	(mg/l)	(lb/day)
MC-1	08/15/02	12.42	<0.02	-	27	1,809	299	20,030
	10/17/02	14.3	<0.02	-	5	386	522	40,260
MC-2	08/15/02	20.95	<0.02	-	24	2,712	293	33,108
	10/17/02	15.9	<0.02	-	5	429	486	41,680
MC-3	08/15/02	20.17	<0.02	-	14	1,523	308	33,508
	10/17/02	15.5	<0.02	-	<5	418	481	40,210
MC-4	08/15/02	17.01	<0.02	-	23	2,110	297	27,249
	10/17/02	14.7	<0.02	-	5	396	489	38,770
MC-5	08/15/02	1.01	<0.02	-	12	65	312	1,698
	10/17/02	0.89	0.034	0.16	60	289	367	1,770

TABLE 3-5
BANK EROSION HAZARD INPUT DATA

Site I.D.	Bank Height (ft)	Bankfull Depth (ft)	Rooting Depth (ft)	Root Density (%)	Bank Slope (degrees)	Bank Surface Protection (%)
EC-1	1.96	0.87	0.75	70	85	80
EC-2	1.89	1.31	0.75	90	64	95
EC-3	5.95	1.16	1.25	85	60	80
MC-1	3.19	0.56	2.0	85	35	95
MC-2	1.33	0.84	2.25	90	9	95
MC-3	2.48	1.09	2.5	95	59	95
MC-4	2.11	0.92	2.5	80	74	80
MC-5	3.40	1.02	1.25	75	84	75
MC-6	1.27	1.20	2.5	80	39	80

TABLE 3-6

BANK ERODIBILITY HAZARD RATING EVALUATION - ECCLES AND MUD CREEKS

Site ID	Bank Height	Bankfull Depth	BH/BF Ratio	BH/BF Index	Rooting Depth	RD/BH Ratio	RD/BH Index	Root Density	Rden Index	Bank Slope	BS Index	Bank Surface Protection	BSP Index	Total Index	Bank Erosion Potential
EC-1	1.96	0.87	2.25	8.22	0.75	0.38	4.83	70	3.19	85	6.84	80	1.00	24.08	Mod
EC-2	1.89	1.31	1.44	5.54	0.75	0.40	4.97	90	1.45	64	4.30	95	1.68	17.93	Low
EC-3	5.95	1.16	5.13	10.00	1.25	0.21	9.78	85	1.23	60	3.90	80	1.00	25.90	Mod
MC-1	3.19	0.56	5.70	10.00	2.00	0.63	2.62	85	1.23	35	2.68	95	1.68	18.20	Low
MC-2	1.33	0.84	1.58	5.92	2.25	1.69	8.13	90	1.45	9	1.41	95	1.68	18.58	Low
MC-3	2.48	1.09	2.28	8.25	2.50	1.01	1.97	95	1.68	59	3.85	95	1.68	17.42	Low
MC-4	2.11	0.92	2.29	8.28	2.50	1.18	3.56	80	1.00	74	5.30	80	1.00	19.14	Low
MC-5	3.40	1.02	3.33	10.00	1.25	0.37	4.68	75	3.58	84	6.63	75	3.58	28.48	Mod
MC-6	1.27	1.20	1.06	1.53	2.50	1.97	10.62	80	1.00	39	2.88	80	1.00	17.02	Low

TABLE 3-7
HYDRAULIC STRESS HAZARD EVALUATION
VELOCITY GRADIENT RATING

Site I.D.	Core* Velocity (fps)	Near Bank Velocity (fps)	Width Distance (ft)	Velocity Gradient (fps/ft)	Stress Rating
EC-1	5.45	0.19	1.5	3.51	Extreme
EC-2	4.65	1.35	6.0	0.55	Very Low
EC-3	5.45	2.34	2.5	1.24	Moderate
MC-1	3.43	1.65	8.0	0.22	Very Low
MC-2	3.72	2.55	4.0	0.29	Very Low
MC-3	3.50	1.84	4.0	0.42	Very Low
MC-4	3.06	1.72	5.0	0.27	Very Low
MC-5	0.67	0.16	2.0	0.26	Very Low
MC-6	-	-	-	-	-

Notes: * (Core Velocity-Near Bank Velocity)/Width Distance

TABLE 3-8
HYDRAULIC STRESS HAZARD EVALUATION
AREA RATING

Site I.D.	Cross-Section Area (ft ²)	Bank Section Area* (ft ²)	Abs/A Ratio	Stress Rating
EC-1	7.45	1.64	0.22	Low
EC-2	6.95	2.18	0.31	Low
EC-3	5.56	1.73	0.31	Low
MC-1	8.00	2.76	0.35	Moderate
MC-2	7.60	2.26	0.30	Low
MC-3	8.10	2.46	0.30	Low
MC-4	7.33	2.01	0.27	Low
MC-5	3.65	0.82	0.22	Low
MC-6	-	-	-	-

Notes: * width*depth for 1/3 of channel width in the near bank region

TABLE 3-9

HYDRAULIC STRESS HAZARD EVALUATION
SHEAR STRESS RATING

Site I.D.	Mean Flow Depth (ft)	Channel Slope (ft/ft)	Mean Flow Shear	Near Bank Depth (ft)	Near Bank Shear	NBS/MFS Ratio	Stress Rating
EC-1	0.93	0.06	3.54	0.69	2.63	0.74	High
EC-2	0.99	0.05	3.15	0.95	3.02	0.96	High
EC-3	0.89	0.02	1.33	0.83	1.24	0.93	High
MC-1	0.57	0.01	0.25	0.60	0.26	1.05	High
MC-2	0.76	0.01	0.57	0.70	0.52	0.92	High
MC-3	0.81	0.03	1.31	0.73	1.18	0.90	High
MC-4	0.67	0.01	0.29	0.53	0.23	0.79	High
MC-5	0.52	0.02	0.51	0.38	0.37	0.72	High
MC-6	-	-	-	-	-	-	-

Notes: * Shear stress = depth*slope*water density



USGS 09810600 ECCLES CANYON NEAR SCOFIELD, UTAH

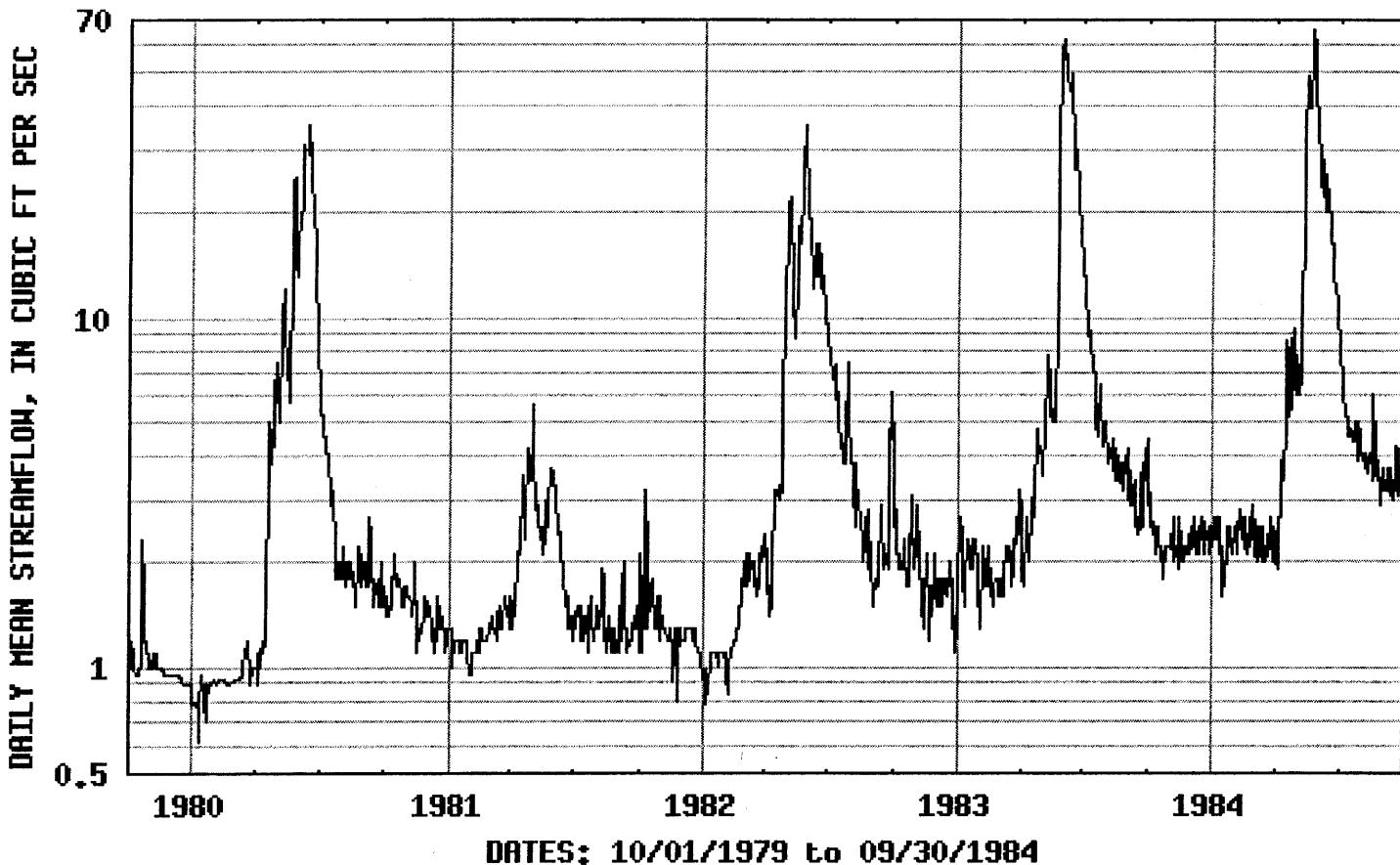


Figure 3-1. USGS Eccles Creek Streamflow Record

Canyon Fuel Company
Skyline Mine

Mine-Water Discharge Impact
December 2002



USGS 09810700 MUD CREEK BL WINTER QUARTERS CANYON AT SCOFIELD, UT

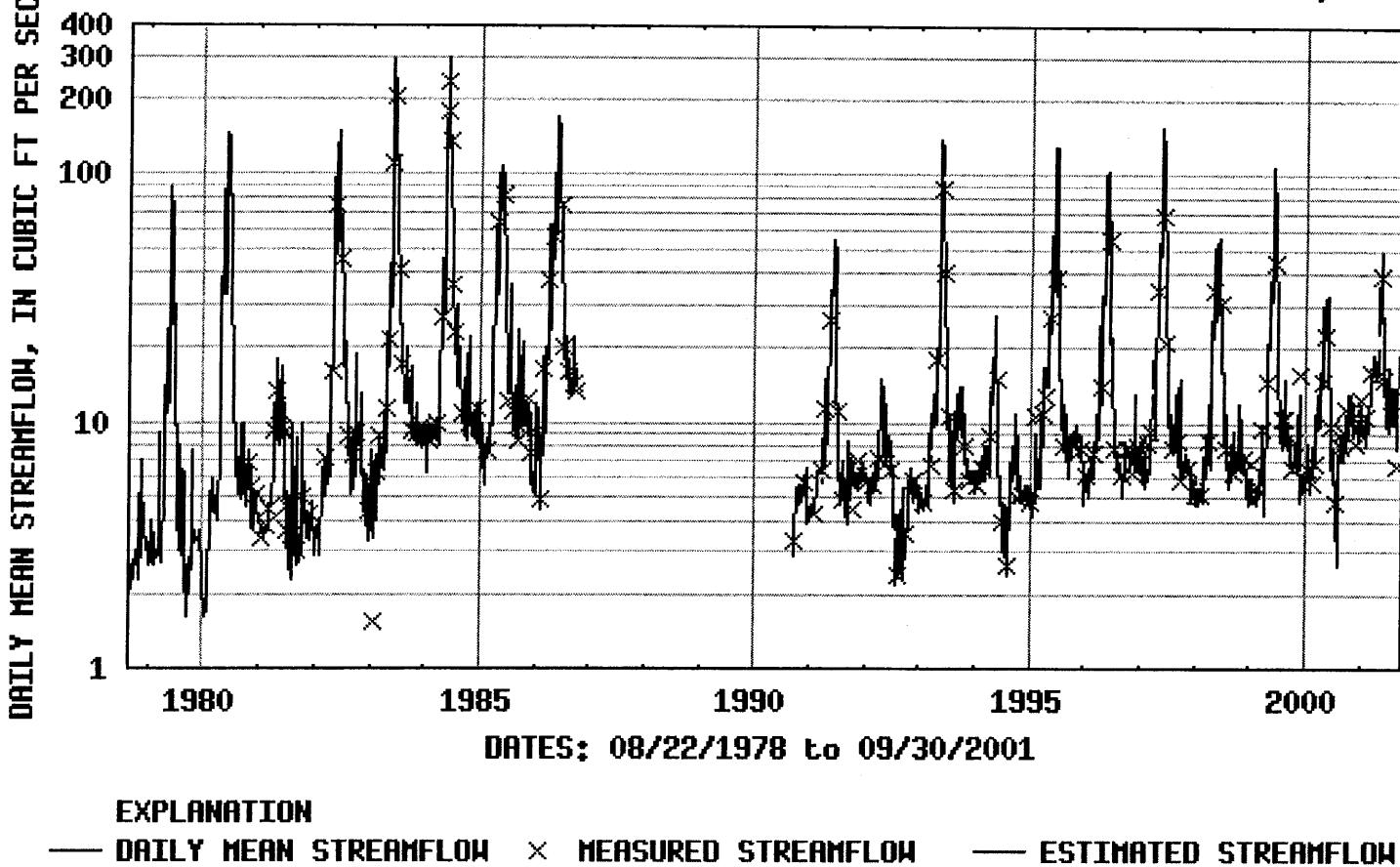


Figure 3-2. USGS Mud Creek Streamflow Record

4.0 REFERENCES

- EarthFax Engineering, Inc. 2002. Hydrologic and Channel-Stability Evaluation of Eccles and Mud Creeks. Letter report submitted to Canyon Fuel Company. Midvale, Utah.
- Harrelson, C.C., C.L. Rawlins, and J.P. Potyondy. 1994. Stream Channel Reference Sites: An Illustrated Guide to Field Technique. General Technical Report RM-245. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station. Fort Collins, Colorado.
- Hem, J.D. 1985. Study and Interpretation of the Chemical Characteristics of Natural Water. U.S. Geological Survey. Water-Supply Paper 2254. Washington, D.C.
- Jensen, E.H. and J.W. Borchert. 1988. Soil Survey of Carbon Area, Utah. U.S. Soil Conservation Service. Salt Lake City, Utah.
- Rosgen, D.L. 1996. Applied River Morphology. Wildland Hydrology. Pagosa Springs, Colorado.
- Rosgen, D.L. 2001. A Practical Method of Computing Streambank Erosion Rate. Proceedings of the Seventh Federal Interagency Sedimentation Conference. U.S. Geological Survey. Reno, Nevada.

Canyon Fuel Company
Skyline Mine

Mine-Water Discharge Impact
December 2002

APPENDIX A

Photographs of Reference Sites



Photograph 1 - EC-1 Cross Section



Photograph 2 - EC-1 View Upstream

Canyon Fuel Company
Skyline Mine

Mine-Water Discharge Impact
December 2002



Photograph 3 - EC-1 View Downstream



Photograph 4 - EC-2 Cross Section



Photograph 5 - EC-2 View Upstream



Photograph 6 - EC-2 Additional View Upstream



Photograph 7 - EC-2 View Downstream

Canyon Fuel Company
Skyline Mine

Mine-Water Discharge Impact
December 2002



Photograph 8 - EC-2 Additional View Downstream



Photograph 9 - EC-3 Cross Section



Photograph 10 - EC-3 View Upstream

Canyon Fuel Company
Skyline Mine

Mine-Water Discharge Impact
December 2002



Photograph 11 - EC-3 Additional View Upstream



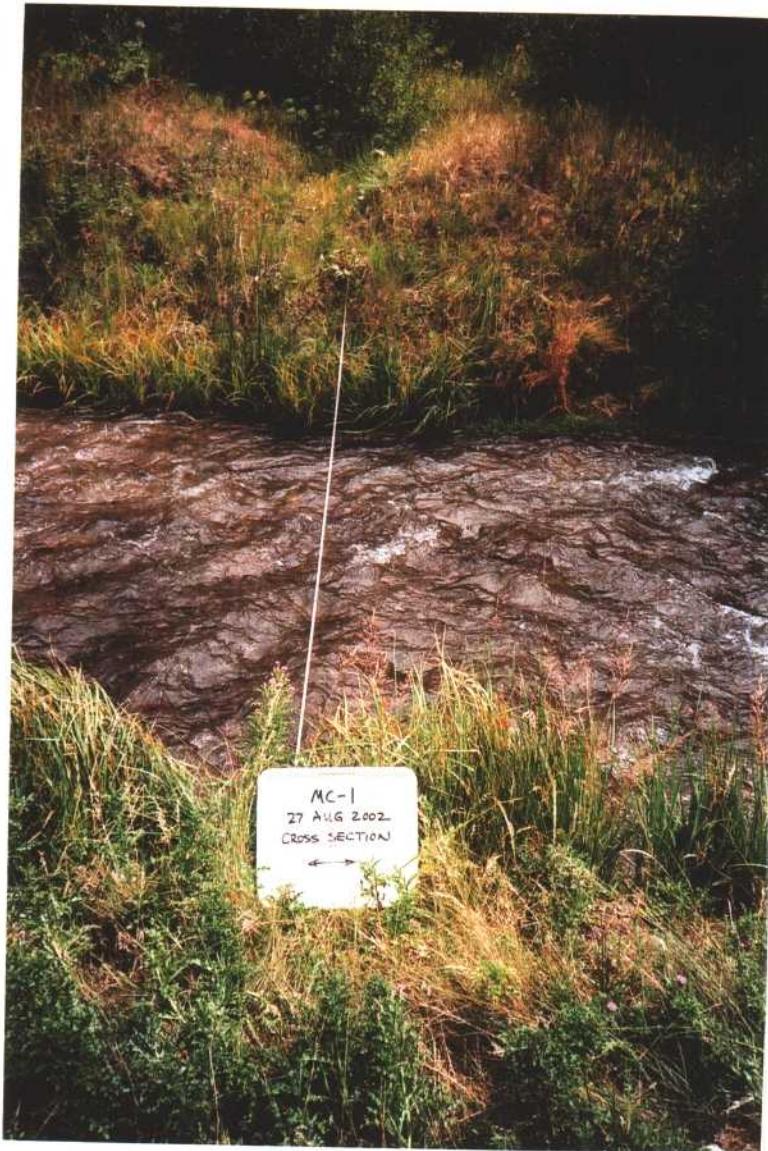
Photograph 12 - EC-3 View Downstream



Photograph 13 - EC-3 Additional View Downstream

Canyon Fuel Company
Skyline Mine

Mine-Water Discharge Impact
December 2002



Photograph 14 - MC-1 Cross Section



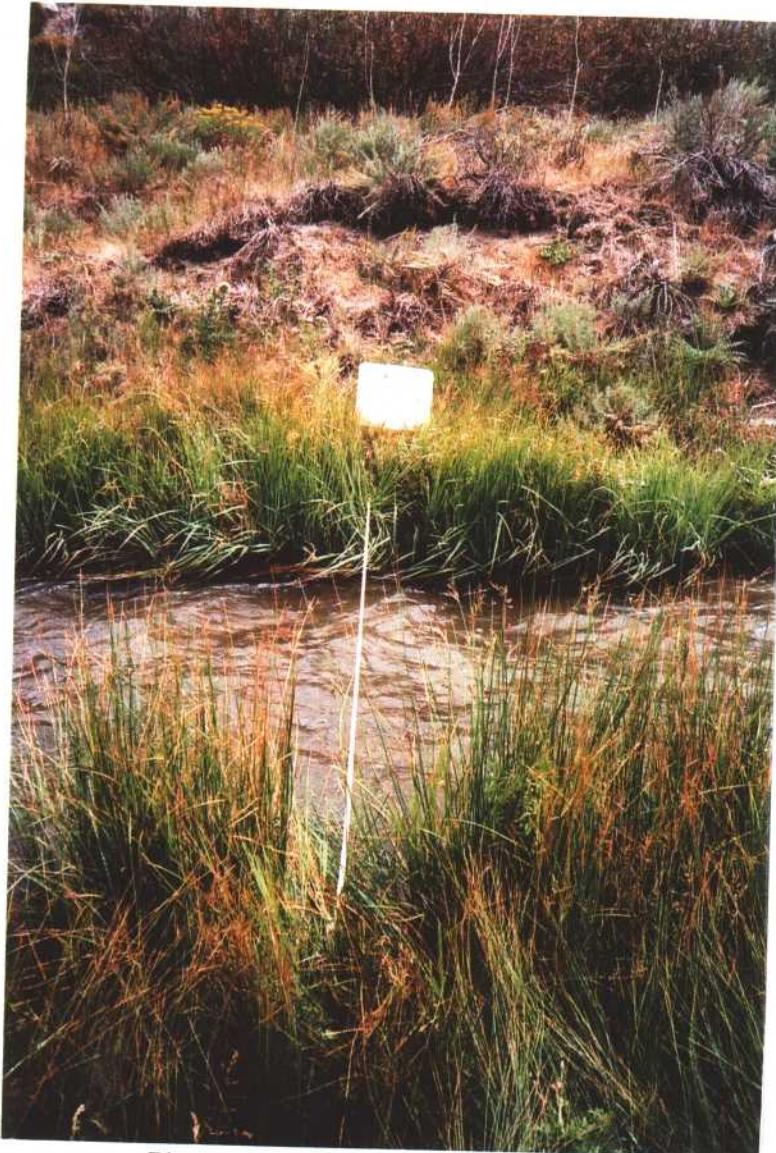
Photograph 15 - MC-1 View Upstream



Photograph 16 - MC-1 View Downstream

Canyon Fuel Company
Skyline Mine

Mine-Water Discharge Impact
December 2002



Photograph 17 - MC-2 Cross Section



Photograph 18 - MC-2 View Upstream



Photograph 19 - MC-2 Additional View Upstream



Photograph 20 - MC-2 View Downstream



Photograph 21 - MC-2 Additional View Downstream

Canyon Fuel Company
Skyline Mine

Mine-Water Discharge Impact
December 2002



Photograph 22 - MC-2 Additional View Downstream



Photograph 23 - MC-3 Cross Section



Photograph 24 - MC-3 View Upstream



Photograph 25 - MC-3 View Downstream



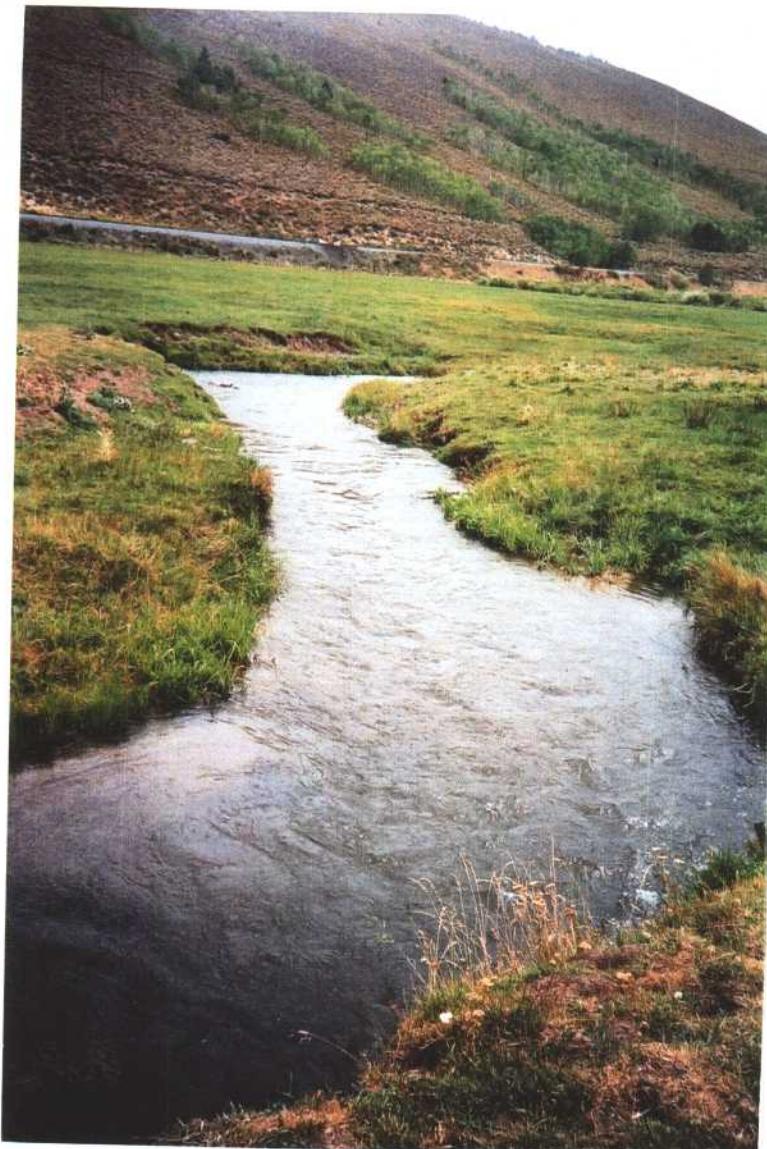
Photograph 26 - MC-4 Cross Section



Photograph 27 - MC-4 View Upstream

Canyon Fuel Company
Skyline Mine

Mine-Water Discharge Impact
December 2002



Photograph 28 - MC-4 Additional View Upstream



Photograph 29 - MC-4 View Downstream



Photograph 30 - MC-4 Additional View Downstream

Canyon Fuel Company
Skyline Mine

Mine-Water Discharge Impact
December 2002



Photograph 31 - MC-4 Additional View Downstream



Photograph 32 - MC-5 Cross Section



Photograph 33 - MC-5 View Upstream

Canyon Fuel Company
Skyline Mine

Mine-Water Discharge Impact
December 2002



Photograph 34 - MC-5 View Downstream



Photograph 35 - MC-6 Cross Section



Photograph 36 - MC-6 View Upstream

Canyon Fuel Company
Skyline Mine

Mine-Water Discharge Impact
December 2002



Photograph 37 - MC-6 View Downstream

Canyon Fuel Company
Skyline Mine

Mine-Water Discharge Impact
December 2002

APPENDIX B

Reproduction of Field Log Books



Name _____

Address

Phone _____

Project _____

Clear Vinyl Protective Slipcovers (Item #32) are available for this style of notebook. Helps protect your notebook from wear & tear. Contact your dealer or the J. L. Darling Corporation.

² EC-1 Approx 100 yds
drains broken from skyline
culvert outlet

Width (ft)	Depth (ft)	Vel. (ft/s)	Q (cfs)	A ft ²
2.0	1.0	1.96	3.92	=
2.0	1.5	5.74	17.22	=
3.0	1.0	0.865	1.70	=
TOTAL =			22.84	

Narrow channel. No flood plain.
Cobbler bottom. Many rocks in back
soil. Could not collect shelly talus
samples. Collected back gravel soil
sample & bed sample. South
slope - evergreens. N. slope -
willows, grasses

³ Cross Section EC-1

Dist (ft)	Depth (ft)	12.8	14.0	15.5	16.4	17.4	18.5	19.5	20.5
2.0	0.96								
5.7	1.38								
6.7	1.83								
7.0	4.10								
10.0	4.60								
12.8	4.32								
14.0	3.73								
15.5	3.15								
16.4	0.65								
		6.75 reading							
		12.8, 14.0, 15.5, 17.4, 18.5, 19.5, 20.5 ft elev							

Man-made structures

- Upper well access → 84" CMP
w/ projecting inlet.
- Lower well access → same as above
- Belize turnoff → 48" CMP,
proj. inlet, submerged outlet
- Cordout turnoff → 72" CMP
w/ headwall & wingwalls
- Chez Cr. road crossing - 120"
CMP w/ projecting inlet
- Pleasant Valley road crossing
0.1 mi from White Oak headout -
72" CMP w/ headwall & wingwalls
- Alpine School road - 2 60"
CMPS + projecting inlet

- Pleasant N. road at White Oak
headout - 72" CMP w/ headwall
and wingwalls

EC-2 — Approx 240 yd
downstream from gas well

Width (ft)	Depth (ft)	Vol. (ft)	Q (ft³/s)
(ft)	(ft)	(ft)	(ft³/s)
2.0	0.9	5.20	9.36
2.0	0.8	4.83	7.76
2.5	1.0	3.21	8.03
TOTAL =		25.15	

No sed samples - well armored
 $D_{50} \approx 4'' - 6''$, Shelby sand
 grab samples collected. Well veg.
 flood plain. (willow & grass)

$D_{25} \approx 8''$

Cross section

Dist (ft)	Depth (ft)	(0,0)
11	5.1	
20	5.4	13 sec
29	5.2	
36	5.1	
44	6.4	
44.5	7.3	
45	7.5	
47	7.5	
51	7.7	
51.5	6.2	
53	5.7	
62	5.2	
71	0.0	

8 EC-3 + Approx 0.3 mi
upstream from Mud Creek
confluence

width	depth	vol.	q
(ft)	(ft)	(ft ³)	(ft ³ /sec)
2.0	1.1	2.24	4.93
2.0	1.3	4.26	11.08
1.5	1.0	3.15	5.48
		Total = 21.49	

All samples collected. Bed
well rounded. Bank well
vegetated (thick grass growth)
Channel meanders in this
reach.

Cross section

D+ (ft)	D- (ft)	Vol (ft ³)
1.0		1.55
6.0		2.25
10.5		2.80
17.0		3.75
21.3		5.00
23.0	WEST BANK	6.43
25.4	MIDDLE	6.40
27.0	EAST BANK	6.4
30.7		4.70
33.6		3.75
47.4		4.50
53.0		3.50
74.0		5.00
85.0		0.50

10

MAC-1 - Approx 120 yd
downstream from confluence of
Eel and Mad Cr.

W.D.	Depth	Vel.	Q	
(ft)	(ft)	(ft/s)	(cfs)	
2.0	0.8	0.565	0.90	1.5
2.0	1.1	2.74	6.03	=
2.0	0.9	3.13	5.63	2.0
2.0	0.6	3.21	3.85	3.5
2.0	0.4	2.34	1.87	1.5

TOTAL = 18.22

Collected all samples. Banks
well vegetated w/ grasses.
Bottom of gravelly materials,

Cross section

11

DIST. FE.	DEPTH FE.
2.0	0.47
7.1	2.90
13.2	3.17
16.8	4.4
21.5	4.35
26.2	3.81
27.5	3.25
31.5	0.72

GPS:

12 0486 828 E
43° 27' 46" N
79° 48'

12

MC-2 - Approx 80 yds

downstream from pt where
creek flows beneath Road.

Width (ft)	Depth (ft)	Vel. (ft/s)	Q (ft ³ /s)
3.0	0.6	2.61	4.70
2.0	0.7	2.55	3.57
2.0	0.7	3.28	4.59
2.0	0.8	3.65	5.84
2.0	0.6	1.96	2.35
Total = 21.05			Flow area = 7.4 ft ²

All samples collected at Bank
well vegetated.

13

Cross section

Dist (ft)	Depth (ft)
2.0	0.60
6.0	1.73
10.7	2.42
13.0	2.43 WEST
13.5	2.30 NORTH
22.0	2.35 EAST
26.4	2.25
27.0	0.60

215 ft. downstream from channel center

14

MC-3 Approx 30 yds upstream
from mid - Scotland Crossing

Width (ft)	Depth (ft)	Vd. (ft)	Q (cu ft)	A (sq ft)
- 2.0	1.0	1.70	3.52	9.6
- 2.0	1.1	2.15	4.73	10.2
- 2.0	0.8	2.74	4.38	10.2
- 2.0	0.8	3.89	6.22	10.2
- 2.0	0.6	3.43	4.12	10.2
- 2.0	0.5	1.47	1.47	10.2

$$\text{TOTAL} = 24.44$$

Collected all samples. Shallow
tube may have had grass in
portion. Bank well veg.
(grasses & willows)

Cross section

15

Dist. (ft)	Depth (ft)
2.0	0.25
8.0	1.85
14.3	3.02
16.0	4.70 west
20.5	4.45 mid.
27.0	4.20 east

GPS:

12 486337 E
4396941 N
6 7703 E

PAGE	CONTENTS	REFERENCE	DATE

2 Aug 2002

Photo log

- 1 Installation of EC-1 benchmark
- 2 Ditto
- 3 Completed EC-1 benchmark w/ adjacent cross section marker
- 4 EC-2 benchmark installed
- 5 EC-2 cross section
- 6 Installation of EC-3 benchmark
- 7 Looking upstream at EC-3
- 8 MC5 benchmark
- 9 MC5 cross section
- 10 Installation of MC-1 benchmark
- 11 Downstream from MC-1
- 12 MC-2 bench mark
- 13 Upstream at MC-2
- 14 Installing MC-4 benchmark
- 15 Looking across valley at MC-4
- 16 Installation of MC-13 benchmark
- 17 Ditto

2 Aug 2002

EC-1

- * Benchmark installed as follows:
 - Excavated hole ~8" diameter x 36" deep with power auger and post-hole digger
 - Poured in dry post mix, added water, and mixed in hole
 - Installed brass cap w/ stamped site number
- * Cross section markers installed as follows:
 - Drove $\frac{1}{2}$ " rebar (4' long) into soil, leaving 2-3" above ground
 - Installed yellow plastic survey cap on rebar
 - Wrote cross section number on cap w/ waterproof marker.
- * Steep adjacent road bank necessitated installation of cross section marker and benchmark immediately adjacent to each other.

EC-2

Installed as above

EC-3

Installed as above

2 Aug 2002

MC-5

Installed as above

MC-1

Installed as above

MC-2

Installed as above

MC-4

Installed as above. Benchmark installed west of private property, in Hwy right of way.

MC-3

Installed as above. Benchmark just north of prop. fence.

Finished for the day.

5 Aug 2002

Photo log (continuing roll from 2 Aug 2002):

- 18 Piezometers at MC-5, prior to cutting stick-up
- 19 First attempt at PMC-1B. Ground too hard. Moved
- 20 Completed PMC-1A
- 21 Completed PMC-1B

5 Aug 2002

Installation of piezometer at MC-5:

- Used hammer drilling and flighted auger to drill to a depth where cuttings were saturated. Hole dia ~ 3".
- Drilled bottom ~ 2' of $\frac{3}{4}$ " PVC w/ $\frac{1}{8}$ " bit, n 1-2" centers.
- Installed $\frac{3}{4}$ " PVC to bottom of hole
- Cut excessive pipe, leaving 3-4" stick up.

PMC-5A → cut 5.75', leaving 4.25' in ground. Left bank, looking upstream
PMC-5B → cut 4.07', leaving 5.93' in ground. Rt bank looking upstream.

Holes completed at ~ 11:00

Valley not wide enough at this location for 2 piezos on each side of stream.
Installed 1 only on each side.

5 Aug 2002

Installation of piezos at MC-1

- Installed as above.
- Valley too narrow for 4 piezos.
- Installed only 2.

PMC-1A → 5.30' pipe in ground,
PMC-1B → 2.49' pipe in ground

Piezos completed at ~ 12:15

Installation of piezos at MC-2

- Installed PMC-2B as above
- Attempted 3 holes to install second piezo on rt side of stream. All hit refusal above water table. Broke bit. Could not be repaired at mine shop.
- Headed for home.

7 Aug 2002

Photo log (continuing from prior roll)

- 22 PMC-2A
23 PMC-2C
24 PMC-2B
25 PMC-2F

26 PMC-5A, Location of 5B in background

New roll of film

- 1 PMC-5A
2 Installation of PMC-5B
3 Perforating PVC at PMC-5C
4 PMC-5E
5 Looking across valley from 5E to 5A
6 PMC-5D
7 PMC-6A
8 PMC-6B (Set up for 6C in background)
9 PMC-6C (set up on 6D in background)
10 PMC-6D
11 View across valley from PMC-6A to 6D

7 Aug 2002

Installation of piezos at MC-2

PMC-2A → installed as above,
10' of PVC in hole. Completed @ 09:15
PMC-2C → installed as above,
10' of PVC in hole. Completed @ 09:45

Installation of Piezos at MC-7

PMC-3A → installed as above, 5' of
PVC in hole. Completed @ 11:50
PMC-3B → installed as above. 5' PVC in
hole. Completed 10:50

Area too narrow for more than two
piezos.

Installation of piezos at MC-5

PMC-5A → Installed as above w/ 4.5'
PVC. Completed at 12:30
PMC-5B → Installed as above w/ 7'
PVC. Completed at 12:50

On west side of creek

7 Aug 2002

PMC-5C → Installed as above w/ 5.5'
PVC. Completed @ 13:20
PMC-5D → As above w/ 5' PVC. Completed
@ 13:50
PMC-5E → As above, w/ 3' PVC. Completed
@ 14:10

On east side of creek:

All PMC-6 piezos installed in
irrigated pasture. Decided to install
additional row of piezos approximately
0.4 mile upstream, in an area that
is not being irrigated. These piezos
will be labeled PMC-6.

PMC-6A → As above, w/ 10' PVC,
Completed 15:30

PMC-6B → As above w/ 8.5' PVC.
Completed 17:25 after drilling problems

PMC-6C → As above w/ 9' PVC.
Completed 18:00

PMC-6D → As above w/ 7.5' PVC.
Completed @ 19:00 @ refuel (damp)

Headed for home

12 Aug 2002

Field work still to be completed:

- Survey channel cross sections & piezos
- Survey longitudinal profiles
- Photograph each reference site
- Collect streamflow data
- Collect WL data from piezos
- Collect bank & bed samples @ MC-4 and MC-5
- Collect bank stability info at all sites

Equipment needs:

- ✓ Level and rod
- ✓ GPS unit
- ✓ 300' tape
- ✓ 100' tape
- ✓ Pin flags
- ✓ Camera and film
- ✓ Flow meter
- ✓ WL indicator
- ✓ Shovels (2)
- ✓ Shelby tubes (2)
- ✓ One-gallon zip lock bags
- ✓ Two 5-gal buckets
- ✓ Sledge hammer

14 Aug 2002

Survey instruments:

Level → Sokkia C40

WL indicator → Slope Indicator 100"

GPS unit → Trimble TSCE. Data will
be downloaded and corrected prior
to printout.

Photo log (continued from prior roll)

12 GPS measurement at MC-5

13 WL measurement at PNC-5A

14 Aug 2002

MC-5 data collection

WL measurements (depth below top of casing)

PMC-5B → 3.32' below TOC

PMC-5A → 2.82' below TOC

Channel width ~ 10'

Profile (BM = 1.40) orientation - looking upstream

Station	Top of Bank Left	Bankfull Left	Water Surfca	Center	Top Bank Right
0+00	2.55	4.40	4.76	5.06	3.15
0+13	1.98	3.93	4.82	5.22	2.50
0+25	2.29	4.30	4.81	5.20	3.59
0+28	2.32	3.68	5.29	5.51	3.00
0+39	2.13	4.26	5.22	6.25	2.10
0+44	2.53	4.72	5.22	6.06	2.98
0+60	2.67	4.75	5.23	5.58	3.45
0+71	1.94	5.07	5.47	5.68	4.01
0+89	2.64	5.42	5.76	6.18	4.63
1+00	3.02	5.40	5.74	6.42	5.01
1+10	4.87	5.58	5.74	6.16	2.48
1+20	4.61	5.42	5.82	6.12	2.16
1+25	5.36	5.80	6.15	6.52	2.04
1+35	5.27	5.87	6.48	7.08	2.23
1+43	5.28	5.85	6.50	6.92	3.28
1+52	5.07	5.81	5.46	7.17	2.77

MC-5 Profile (cont.)

14 Aug 2002

Station	Top Bank Left	Bankfull Left	Water Surfca	Bottom Center	Top Bank Right
1+60	3.26	6.08	6.47	7.02	5.35
1+78	3.08	6.00	6.60	7.08	5.56
1+84	4.72	6.25	6.60	7.30	5.50
1+97	5.50	6.25	6.62	7.07	5.58

(BM close → 1.40)

Location of cross section end points (from BM):

Lt - S 35° W, 13.6'

Lt - S 43° E, 53.6'

PMC-5B TOC = 1.75

Ground = 2.05

PMC-5A TOC = 2.56

Ground = 2.80

Collected shelly tube and disturbed soil samples from right bank, approx 50' downstream from cross section. Bottom sed sample from X sec. location.

Piezo locations w/ respect to BM:

PMC-5A = S 42° E, 36.8'

PMC-5B = S 14° W, 6.6'

14 Aug 2002

MC-5 cross section

Station Elev.

0+00 1.30

0+05 2.33

0+07 2.76

0+24 2.97

0+32 3.86

0+33 5.09

0+33.1 6.14

0+37 6.45

0+40 5.82

0+44 5.03

0+45 4.82

0+48 4.55

0+50 2.83

0+52 2.01

Left stake ground

Left bottom stream

Center bottom

Rt bottom

Rt stake ground

$$\text{BM close} = 1.40$$

MC-1 Data collection

$$\text{PMC-1A} = 4.32 \text{ below TOC}$$

$$\text{PMC-1B} = 1.84 \text{ below TOC}$$

MC-1 profile (BM = 0.74)

14 Aug 2002

<u>Station</u>	<u>Top Bank Left</u>	<u>Bentfull Left</u>	<u>water surf</u>	<u>Bottom center</u>	<u>Top Bank right</u>
0+00	1.73	3.53	4.13	5.93	2.85
0+27	3.94	4.14	4.26	5.95	2.73
0+45	4.05	4.22	4.26	6.68 (-1.04)	
0+65	4.04	4.33	4.38	5.43	0.93
0+78	3.08	4.48	4.56	5.60	1.45
0+90	4.65	4.75	4.75	5.70	2.61
1+10	4.50	4.93	4.95	5.70	1.83
1+24	4.47	5.04	5.04	5.72	1.37
1+37	5.26	5.35	5.36	5.94	2.28
1+50	3.56	5.49	5.51	6.05	2.88
1+65	5.26	5.88	5.88	6.46	5.32
1+80	5.66	5.97	5.97	6.94	5.74
1+95	4.08	5.91	6.09	6.90	5.07
2+10	4.99	6.12	6.15	7.68	5.12
2+25	2.88	5.90	6.30	7.09	5.02
2+40	6.15	6.45	6.45	7.00	6.07
2+55	6.52	6.75	6.75	7.41	4.90
2+70	4.55	6.75	6.75	7.42	4.10
2+85	6.17	6.17	6.87	7.71	4.52
3+00	4.66	5.66	6.96	7.73	4.98

$$\text{BM close} = 0.74$$

PMC-1A → Need turning pt

PMC-1B = 4.24 TOC, 4.51 ground

} Approx
sta 2+20

14 Aug 2002

Cross section end pts (from BM)

Left = N 20° E, 33.7'

Right = N 90° E, 16.7'

Piezo locations (from BM)

MB-1A = N 50° E, 91.6'

ML-1B = N 20° E, 80.7'

Cross section

Sta	Elev.	
0+00	1.21	Left stake
0+03	2.82	
0+06	5.39	
0+08	5.56	Left stream channel
0+15	6.00	Stream centre
0+22	5.52	Rt stream
0+26	2.73	
0+27	2.51	
0+32	1.66	Rt stake

Reset level to shoot PMC-1A

New BM level = 0.94

PMC-1A = 1.38 TOC
1.63 ground

BM elev. = 0.94

MC-2 data

14 Aug 2002

Piezo WLS:

PMC-2A = 8.20' below TOC

PMC-2B = 5.04' below TOC

PMC-2C = 8.83' below TOC

Cross section end pts (from BM):

Rt = S 30° E, 14.2'

Lft = S 60° E, 43.9'

Piezo locations (from BM):

PMC-2A: S 57° E, 60.4'

PMC-2B: S 15° E, 16.4'

PMC-2C: S 70° E, 108.0'

Piezo elev.:

PMC-2A = 1.59' TOC, 2.85' ground

PMC-2B = 5.51 TOC, 6.62 ground

PMC-2C = 0.72' TOC, 1.56 ground

At elev.
make
sta
1+50

Channel 10-20' wide. Extend profile 150'
upstream & downstream from X sec.

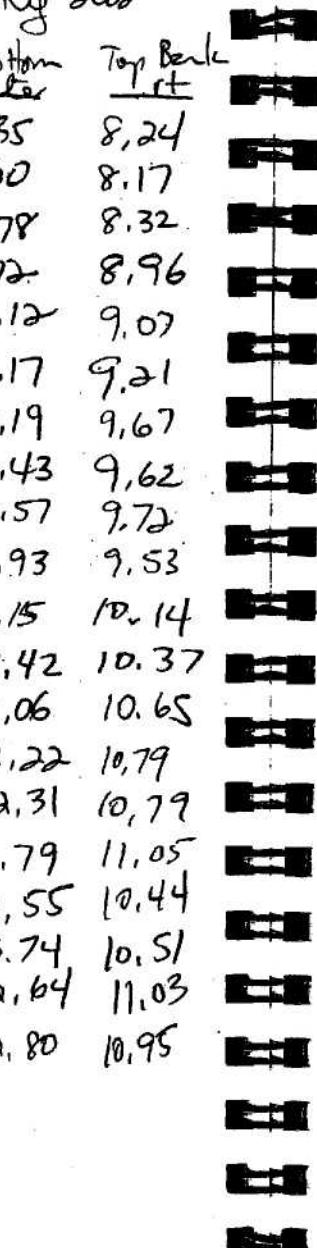
BM elev. = 5.34'

Profile (MC-2)

14 Aug 2002

station	Top Bank Left	Bankfull Left	Water Surf	Bottom Center	Top Bank Rt
0+00	7.62	8.42	8.52	9.35	8.24
0+15	8.13	8.71	8.71	9.60	8.17
0+30	8.40	8.78	8.88	9.78	8.32
0+45	8.39	8.97	8.97	9.72	8.96
0+60	8.11	9.08	9.15	10.12	9.07
0+75	8.71	9.47	9.47	10.17	9.21
0+90	8.44	9.49	9.56	10.19	9.67
1+05	8.98	9.63	9.74	10.43	9.62
1+20	8.70	10.00	10.00	10.57	9.72
1+35	8.92	10.13	10.13	10.93	9.53
1+50	9.82	10.31	10.31	11.15	10.14
1+65	10.44	10.60	10.60	11.42	10.37
1+77	9.70	10.63	10.86	12.06	10.65
1+93	10.19	10.86	10.86	12.22	10.79
2+10	10.56	11.09	11.09	12.31	10.79
2+25	10.18	11.21	11.21	12.79	11.05
2+40	10.05	11.12	11.25	13.55	10.44
2+55	9.09	11.36	11.52	13.74	10.51
2+70	10.37	11.51	11.51	12.64	11.03
2+85	10.35	11.30	11.65	12.80	10.95

BM close = 5.34



MC-2 cross section

14 Aug 2002

Sta	Elev	Comments
0+00	6.68	Left stake
0+03	8.55	
0+06	10.15	Left stream
0+07	10.37	Left stream channel
0+12	11.19	Center stream
0+18	10.35	
0+19	10.29	Rt stream
0+29	7.69	
0+39	6.78	

BM close = 5.34

14 Aug 2002

MC-6 data

BM → UDOT marker
 C/L SD
 Sta. 944 }
 Elevation ? }
 1959 }
 GPS on top of
 this marker

WLS:

Sta	Elev	WL (below TDC)
BM (UDOT)	2.89	
PMC-6A (TDC) 7765.31 (ground)	-1.78 -2.70	6.23 59.77
PMC-6B (TDC) 7761.96 (grnd)	-4.39 -4.88	6.10 56.56
PMC-6C (TDC) 7761.73 (grnd)	-4.49 -4.92	7.09 55.07
PMC-6D (TDC) 7761.78 (grnd)	-3.75 -4.23	Dry (>7.25 from TDC) 55.00
Stream water surface at section 7755.89	10.12	↑ 55.09

Probe down

Piezoelectric locations surveyed w/ GPS
 (ground surface adjacent to piezo)

MC-4 data

14 Aug 2002

Will GPS benchmark and all piezo
 locations

Water levels:

Sta	Elev	Depth to WL (from TDC)
PMC-4A (TDC) (grnd)	11.10	1.38
PMC-4B (TDC) (grnd)	11.14	3.62
PMC-4C (TDC) (grnd)	11.77	
PMC-4C (TDC) (grnd)	11.71	3.95
PMC-4D (TDC) (grnd)	11.76	
PMC-4D (TDC) (grnd)	5.50	0.65
PMC-4E (TDC) (grnd)	5.96	
Piezoelectric locations	1.16	0.93

Piezoelectric profile sta 1+20

BM = 10.73

(shot at end of piezo survey)

Sta	MC-4 profile (BM = 4,24)					14 Aug 2002
	Top Bank Left	Benthic Left	Wetx Surf	Bottom	Top Bank Rt	
0+00	7.46	8.05	8.20	8.78	8.52	
0+15	6.96	8.19	8.45	9.40	7.37	
0+30	9.96	8.64	8.64	10.11	7.16	
0+45	8.33	8.65	8.65	9.40	6.80	
0+60	7.75	8.74	8.74	9.40	7.03	
0+75	8.52	8.83	8.83	9.77	7.89	
0+90	8.60	8.99	8.99	9.60	7.78	
1+05	8.71	8.96	8.96	10.08	6.50	
1+20	8.86	9.01	9.01	11.08	5.67	
1+35	7.72	8.62	9.03	10.02	7.67	
1+50	7.81	9.00	9.12	9.92	7.94	
1+65	6.99	9.22	9.22	9.85	7.87	
1+80	7.80	9.30	9.30	10.67	9.29	
1+95	8.08	9.47	9.47	10.51	8.04	
2+10	9.20	9.54	9.54	10.40	8.35	
2+25	9.29	9.52	9.55	11.44	6.18	
2+40	9.32	9.55	9.55	11.51	6.70	
2+55	9.34	9.55	9.55	11.55	6.45	
2+70	9.12	9.50	9.58	11.10	6.17	
2+85	9.36	9.58	9.58	10.81	6.46	
3+00	9.52	9.68	9.68	11.59	8.15	

BM close = 4,25

14 Aug 2002

MC-4 cross sect

14 Aug 2002

Sta	Elev	Comments
0+00	5.73	Left stake grid
0+05	7.69	Left edge stream
0+10	7.76	Left edge stream
0+12	9.78	
0+17	9.82	Bottom center
0+23	9.44	Rt edge stream bottom
0+23.5	7.67	
0+43	6.85	
0+51	5.99	

BM close = 4,24

Shelby tube f grab samples collected
abt 10 ft upstream from X sec.

Bottom sed sample collected from
X sec location

Cross section stake locations (w/ respect to BM)

Left bank = S 80° E 130.4'

Rt bank = N 87° E 185.1'

MC-3 data collection

14 Aug 2002

GPS bench mark & piezos

WL measurements: BM = 9.72

<u>Sta</u>	<u>Elev</u>	<u>WL (TDC)</u>
PMC-3A (TDC)	9.77	3.56
(grnd)	10.00	
PMC-3B (TDC)	10.07	3.44
(grnd)	10.73	

BM close = 9.72

Will collect profile and cross section
data later.

Other data

Collected GPS data from BMs at
EC-1, EC-2 and EC-3. Will collect
profile & X sec data later.

Water temp at EC-1 = 16°F

GPS reading at EC-1 taken w/ extended
rod (8.8')

14 Aug 2002

20 Aug 2002

BM = 7.53

<u>Sta</u>	<u>Top Bank Left</u>	<u>Bottom Left</u>	<u>Wet Surf.</u>	<u>Bottom</u>	<u>Top Bank</u>
0+00	In beaver pond		6.99	Water > 4' deep	
0+15	In beaver pond		6.95		
0+30	2' upstream from dam		6.97	10.47	Pond is 24.4' wide here
0+45	9.74	10.18	10.18	11.23	9.27
0+60	10.40	10.27	10.27	11.49	9.07
0+75	10.30	10.48	10.48	11.08	9.83
0+90	7.72	10.61	10.61	11.26	10.29
1+05	8.30	10.73	10.73	11.81	9.93
1+20	9.20	10.91	10.91	11.81	8.75
1+35	9.83	11.15	11.15	12.09	9.10
1+50	9.77	11.16	11.16	12.25	10.04
1+65	9.84	11.27	11.27	12.28	8.94
1+80	9.88	11.37	11.37	12.47	10.25
1+95	9.22	11.60	11.60	12.47	8.68
		6' diameter culvert, next sta 12' down from outlet			
2+55	10.97	12.10	12.10	13.26	11.10
2+70	11.35	12.30	12.30	13.41	11.09
2+85	12.18	12.33	12.33	13.82	9.72
2+96	11.54	12.31	12.31	13.74	12.15
3+00	13.09	13.47	13.47	14.67	12.37

BM close = 7.53

Photo log (continue w/ prior roll)

22 Aug 2002

- 15 Profile survey at MC-3 - center of stream
- 16 X sec at MC-3 - surveying
- 17 Laying out profile markers downstream from EC-2
- 18 Profile survey at EC-1, looking upstream

Cross section at MC-3

Sta	Elev.	Comments
0+00	8.24	Left stake
0+04	9.47	
0+07	9.96	
0+08	11.65	Left edge of stream bottom
0+17	12.19	Thalweg
0+18	12.21	Rt edge stream bottom
0+21	10.12	
0+24	8.90	
0+28	8.87	
0+30	8.17	Rt stake

$$BM \text{ check} = 7.52$$

EC-3 profile BM = 4.96

20 Aug 2002

Sta	Top Bank Left	Bankfull Left	Water surf	Bottom	Top Bank Rt
0+00	6.75	6.95	6.95	9.08	5.30
0+10	5.70	6.80	6.98	8.49	5.46
0+20	2.83	7.18	7.37	8.96	7.11
0+30	7.21	7.83	7.83	9.86	6.23
0+40	6.53	8.24	8.24	9.01	2.63
0+50	7.89	8.41	8.41	10.29	2.50
0+60	8.04	8.45	8.45	10.50	3.00
0+70	7.98	8.48	8.48	10.04	2.42
0+80	2.70	7.90	9.00	10.01	3.22
0+90	7.95	9.16	9.36	11.27	3.38
1+00	6.64	9.86	9.86	11.02	5.07
1+10	7.55	9.71	10.08	11.35	6.95
1+20	7.39	10.00	10.19	11.59	7.91
1+30	8.33	10.72	10.89	12.61	8.79
1+40	8.35	10.85	10.98	12.38	9.43
BM check = 4.96 Move level. New BM shot = 1.99					
1+50	7.80	8.59	8.59	9.35	5.06
1+60	8.59	8.74	8.74	10.37	8.29
1+70	7.21	9.21	9.41	10.87	8.85
1+80	8.77	9.46	9.46	11.06	9.13
1+90	9.21	9.80	9.80	11.01	5.27
2+00	7.09	9.99	9.99	11.09	9.02

$$BM \text{ close} = 1.99$$

old vertical cut bank (RHS, exposing tree roots)

EC-3 cross section

20 Aug 2002

<u>Sta</u>	<u>Elev</u>	<u>Comments</u>
0+00	2.34	left stake
0+07	3.39	
0+15	3.92	
0+20	7.65	Bottom left stream
0+23	8.86	Thalweg
0+25	7.70	Bottom rt. stream
0+26	6.50	
0+19	5.86	
0+31	2.40	Right stake

$$BM \text{ close} = 1.99$$

EC-2 profile

5.53
~~5.82~~

20 Aug 2002

<u>Sta</u>	<u>Top Bank Left</u>	<u>Bankfull Left</u>	<u>WATER SURF</u>	<u>Bottom</u>	<u>Top Bank pt</u>
0+00	3.37	3.28	3.28	4.25	2.97
0+10	3.34	3.51	3.51	4.96	3.75
0+15	2.98	3.95	4.11	5.43	3.83
0+20	3.68	3.93	4.11	5.46	3.87
0+30	4.10	4.38	4.38	5.33	4.22
0+35	4.22	4.48	4.48	5.67	4.50
0+45	4.70	4.91	4.91	5.45	4.54
0+50	5.13	5.58	5.58	7.36	4.76
0+60	5.15	5.68	5.80	6.67	5.30
0+70	5.80	5.94	5.94	7.24	6.10
0+75	5.91	6.27	6.27	7.88	6.00
0+80	6.01	6.28	6.28	7.50	5.79
0+85	6.21	6.61	6.61	7.61	6.19
0+90	6.18	6.72	6.72	7.78	6.79
1+00	6.32	6.90	6.90	8.21	7.01
1+04	7.04	7.43	7.43	8.94	6.98
1+14	7.61	8.12	8.20	8.96	6.28
1+20	7.93	8.22	8.22	9.48	7.58
1+26	7.46	8.20	8.20	9.51	8.37
1+30	7.68	8.23	8.23	10.18	8.35
1+37	8.08	8.91	8.91	10.60	8.82
1+40	7.94	8.94	8.94	10.71	8.45
1+50	7.74	9.16	9.16	10.48	8.06

Continued next pg

EC-2 profile (cont.).

20 Aug 2002

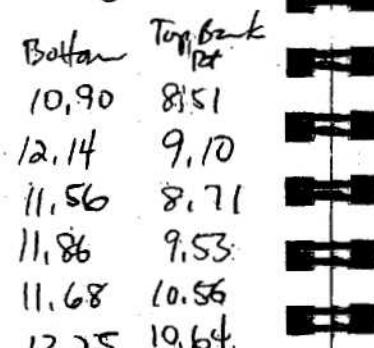
Sta	Top bank left	Bankfull left	Water surf	Bottom	Top bank rt
1+57	8.41	9.38	9.38	10.90	8.51
1+65	8.73	9.75	9.75	12.14	9.10
1+70	8.69	9.82	9.82	11.56	8.71
1+80	8.62	10.22	10.22	11.86	9.53
1+95	9.86	10.18	10.18	11.68	10.56
2+00	10.27	11.50	11.50	13.25	10.64

BM close = 5.53

EC-2 cross section

Sta	Elev.	Comments
0+00	4.61	Left stake
0+05	6.43	
0+22	6.29	
0+25	7.00	
0+26	7.85	Left stream bottom
0+29	8.20	Thalweg
0+32	7.66	Rt stream bottom
0+32.2	7.24	
0+36	6.10	
0+56	5.63	
0+63	4.61	
0+69	2.60	Rt stake

BM close = 5.53



EC-1 profile

20 Aug 2002

Rock in stream approx 20' upstream from BM = 2.31

Move instrument upstream

Shoot back to rock → 7.32

Sta	Top Bank left	Bankfull left	Water surf	Bottom	Top Bank rt
0+00	0.05	2.35	2.85	4.70	1.55
0+10	2.57	3.45	3.45	5.01	2.58
0+20	3.53	4.47	4.47	6.01	3.34
0+30	4.76	5.02	5.02	6.22	4.17
0+40	5.38	5.82	5.82	7.15	5.32
0+50	3.82	6.05	6.87	7.54	5.65
0+60	6.36	6.93	7.20	8.09	6.86
0+70	6.21	7.48	7.48	8.64	6.25
0+80	6.18	8.11	8.11	9.49	6.51

Top of aforementioned rock = 7.31

Move instrument downstream

Shoot back to rock = 1.55

Shoot to BM = 0.15

Resume profile survey

0+90	2.47	3.1b	3.1b	4.04	2.46
1+00	2.58	3.17	3.17	4.48	2.12
1+10	1.61	3.40	3.40	4.31	2.71
1+20	2.00	3.70	3.70	5.42	3.40
1+30	4.77	4.96	4.96	6.26	4.73
1+40	5.03	5.32	5.32	6.35	4.45

Continued on next pg



Ec-1 profile (cont.)

Sta	Top Bank Left	Bentfield Left	Water surf	Bottom	Top Bank rt
1+50	6.12	6.40	6.40	7.35	4.64
1+60	6.35	6.79	6.79	8.23	6.73
1+70	7.19	7.56	7.56	8.27	7.20
1+80	8.06	8.11	8.11	9.10	7.08
1+90	8.41	8.76	8.76	10.78	6.12
2+00	8.88	9.58	9.58	11.17	9.64
BM close = 0.16					

20 Aug 2002

Ec-1 cross section New instrument location.

Sta	Elev.	Comment
0+00	6.60	Left stake
0+02	10.24	Left stream bottom
0+03	10.89	→
0+06	11.73	Thalweg
0+10	11.33	Rt stream bottom
0+10.2	8.99	Rock
0+14	8.02	Rock
0+17	7.44	Rt stake
BM close = 7.43		

27 Aug 2002

Collection of streamflow data

Photo log (continue w/ prior roll):

- 19 EC-1 cross section (R to L)
- 20 EC-1 upstream
- 21 EC-1 downstream
- 22 EC-2 cross section (R to L)
- 23 EC-2 upstream
- 24 EC-2 downstream
- 25 EC-2 from pt approx 50' upstream from cross section, looking upstream
- 26 EC-2 from pt approx 50' downstream from cross section, looking downstream

→ New Roll →

- 1 EC-3 cross section (R to L)
- 2 EC-3 upstream
- 3 EC-3 downstream
- 4 EC-3 up, from 30' up from X sec.
- 5 EC-3 down, from 30' down from X sec.
- 6 MC-5 cross section
- 7 MC-5 upstream
- 8 MC-5 downstream

27 Aug 2002

EC-1

Width (ft)	Depth (ft)	Vel. (fps)	Flow (cfs)	Comments
1.50	0.95	2.20	3.14	
1.50	1.10	4.07	6.72	
1.50	1.30	5.45	10.63	
1.50	0.95	0.193	0.28	
NB 1.60	2.00	0.50	0.818	0.32

1. Site finished 10:45 21.57

EC-2

Width (ft)	Depth (ft)	Vel (fps)	Flow (cfs)
1.50	0.85	1.35	1.72
1.50	1.05	3.57	5.62
1.50	0.90	3.45	4.93
1.50	1.00	4.65	6.98
NB 1.60	1.00	1.25	2.05

2. Site finished 11:25 21.40

EC-3

Width (ft)	Depth (ft)	Vel. (fps)	Flow (cfs)
1.25	0.85	3.37	3.58
1.25	0.80	5.08	5.08
1.25	0.90	5.45	6.13
1.25	1.05	4.37	5.74
1.25	0.85	2.34	2.49

Site finished 12:05 23.01

27 Aug 2002

EC-5

Width (ft)	Depth (ft)	Vel. (fps)	Flow (cfs)
3.00	0.35	0.183	0.19
1.00	0.45	0.615	0.28
1.00	0.65	0.674	0.44
1.00	0.70	0.359	0.25
1.00	0.80	0.162	0.13

Site finished 12:45 1.29

Alert
3.65
NB
0.82

MC-1

27 Aug 2002

<u>Width</u> (ft)	<u>Depth</u> (ft)	<u>Vel.</u> (fps)	<u>Flow</u> (cfs)
2.0	0.65	1.65	2.15
2.0	0.55	2.55	2.81
2.0	0.55	2.74	3.01
2.0	0.50	3.28	3.28
2.0	0.55	3.43	3.77
2.0	0.50	2.50	2.50
2.0	0.70	2.74	3.84

Site finished 13:25 15.02

MC-2

<u>Width</u> (ft)	<u>Depth</u> (ft)	<u>Vel</u> (fps)	<u>Flow</u> (cfs)
2.0	0.60	2.74	3.29
2.0	0.80	3.43	5.49
2.0	0.90	3.72	6.70
2.0	0.80	3.65	5.84
2.0	0.70	2.55	3.57

Site finished 13:55

24.88

A.M. 8:00

N.B.
2:16X
1:16
N.B.
2:16

Photo log (Continued)

- 9 MC-1 cross section (R to L)
- 10 MC-1 upstream
- 11 MC-1 downstream
- 12 MC-2 cross section (R to L)
- 13 MC-2 upstream
- 14 MC-2 downstream
- 15 MC-2 up, from 30' upstream
- 16 MC-2 down, from 30' downstream
- 17 MC-2 down, from 50' downstream
- 18 MC-4 cross section (R to L)
- 19 MC-4 upstream
- 20 MC-4 downstream
- 21 MC-4 up, from 30' upstream
- 22 MC-4 down, from 50' downstream
- 23 MC-4 further down, from 50' downstream
- 24 MC-3 cross section
- 25 MC-3 upstream
- 26 MC-3 downstream

— New Roll —

- 1 Beaver dam, 120' up from MC-3
- 2 Pond above beaver dam
- 3 Downstream from culvert below MC-3

MC-4

27 Aug 2002

CHANNEL

AREA

T-33

NO 3
AREA

2.0

Width (ft)	Depth (ft)	Vel. (fps)	Flow (cfs)
2.0	0.40	1.72	1.38
1.5	0.70	2.68	2.81
1.5	0.70	2.86	3.00
1.5	0.70	3.06	3.21
1.5	0.80	2.74	3.29
1.5	0.75	3.06	3.44
1.5	0.70	3.06	3.21

Site finished 14:30 13.69

MC-3

CHANNEL

AREA

B-1

NO 3
AREA

2.40

Width (ft)	Depth (ft)	Vel. (fps)	Flow (cfs)
2.0	0.90	2.61	4.70
2.0	0.90	3.43	6.17
2.0	0.80	3.50	5.60
2.0	0.65	2.55	3.32
2.0	0.80	1.84	2.94

Site finished 15:00 22.73

22 Nov 2002

• Installed permanent cross section
markers for MC-6

• Survey bench mark will be UDOT
bench mark on east side of road, adjacent
to piezometer.

• Bench mark & piezometers surveyed
previously w/ GPS

MC-6 cross section (looking upstream)

BM = 3.22

Sta	Elev(ft)	Comments
0+00	5.50	Left bank stck
0+01	6.50	
0+07	11.46	Left bottom
0+09	11.65	Thel weg
0+17	11.05	Rt bottom
0+22	10.34	
0+23	10.08	
0+51	10.41	
0+58	6.90	
0+61	6.75	
0+63	5.33	Rt bank stck

MC-6 profile

22 Nov 2002

Sta	Top Bank Left	Bankfull Left	Water Surf	Thalweg Bottom	Top Bank Rt
0+00	6.02	8.61	8.61	9.37	8.05
0+25	6.56	8.91	8.91	9.78	8.45
0+45	9.04	9.08	9.08	10.20	8.19
0+65	9.25	9.23	9.23	10.52	9.04
0+85	9.31	9.29	9.29	10.10	8.58
1+05	9.38	9.58	9.58	10.60	8.84
1+25	9.01	9.83	9.83	10.49	9.32
1+45	8.77	10.15	10.15	11.38	9.36
1+65	9.79	10.23	10.23	11.47	9.38
1+85	10.25	10.36	10.36	11.72	10.05
2+05	10.33	10.41	10.41	11.42	10.12
2+25	x section location 9.24	10.55	10.55	11.75	10.48
2+45	10.19	10.78	10.78	11.52	10.74
2+65	10.78	11.05	11.05	12.28	11.09
2+85	10.70	11.37	11.37	13.29	11.29
3+05	11.27	11.56	11.56	13.03	11.29
3+25	11.45	11.65	11.65	12.52	11.11
3+45	11.31	11.63	11.63	13.04	8.33
3+65	11.80	11.96	11.96	13.10	6.26
3+85	11.58	12.23	12.23	13.07	6.32
4+05	11.71	12.25	12.25	13.13	11.38
4+25	11.95	12.42	12.42	14.55	12.30
4+50	11.90	12.46	12.46	13.25	11.83

BM close = 3.21

22 Nov 2002

- Took photos of MC-6 cross section and profile (up- and downstream)
- Collected samples:
 - Shallow tubes from right bank
 - Grab (from left bank)
 - Bed

At cross section

Cross section marker on rt bank is 24° due E east of UDOT bench mark.

Elev. staked on UDOT bench mark is 7752.14 (date 1959)
Stake 944

Canyon Fuel Company
Skyline Mine

Mine-Water Discharge Impact
December 2002

APPENDIX C

Channel Bed and Bank Sample Data

SUMMARY OF TEST DATA

HOLE NO./ SAMPLE NO.	DEPTH BELOW GROUND SURFACE	STANDARD VOID RATIO e	IN-PLACE DENSITY		GRADATION			ATTERBERG LIMITS			SOIL CLASSIFICATION UNIFIED SYSTEM
			BULK SPECIFIC GRAVITY	MOISTURE PERCENT	% SAND	% GRAVEL	% PASSING NO. 200 SIEVE				
EC-1S	NA			21.0	47.0	31.0	22.0	NON-PLASTIC			SM
EC-2S	NA	2.2	2.454	23.0	37.0	43.0	20.0	NON-PLASTIC			SM
EC-3S	NA			36.0	50.0	0.0	50.0	40.7	-	-	SM-ML
MC-1S	NA	2.7	2.575	28.0	37.0	0.0	63.0	30.7	31.1	-	ML
MC-2S	NA			25.0	37.0	0.0	63.0	34.0	21.6	12.4	CL
MC-3S	NA	2.8	2.499	49.0	39.0	7.0	54.0	38.6	-	-	ML-SM

**SKYLINE MINES DISCHARGE STUDY
EARTHFAK ENGINEERING**

Project: Skyline Mines Discharge Study
Client: Earthfax Engineering
Project #: 401356

LABORATORY SUMMARY

CMT ENGINEERING LABORATORIES

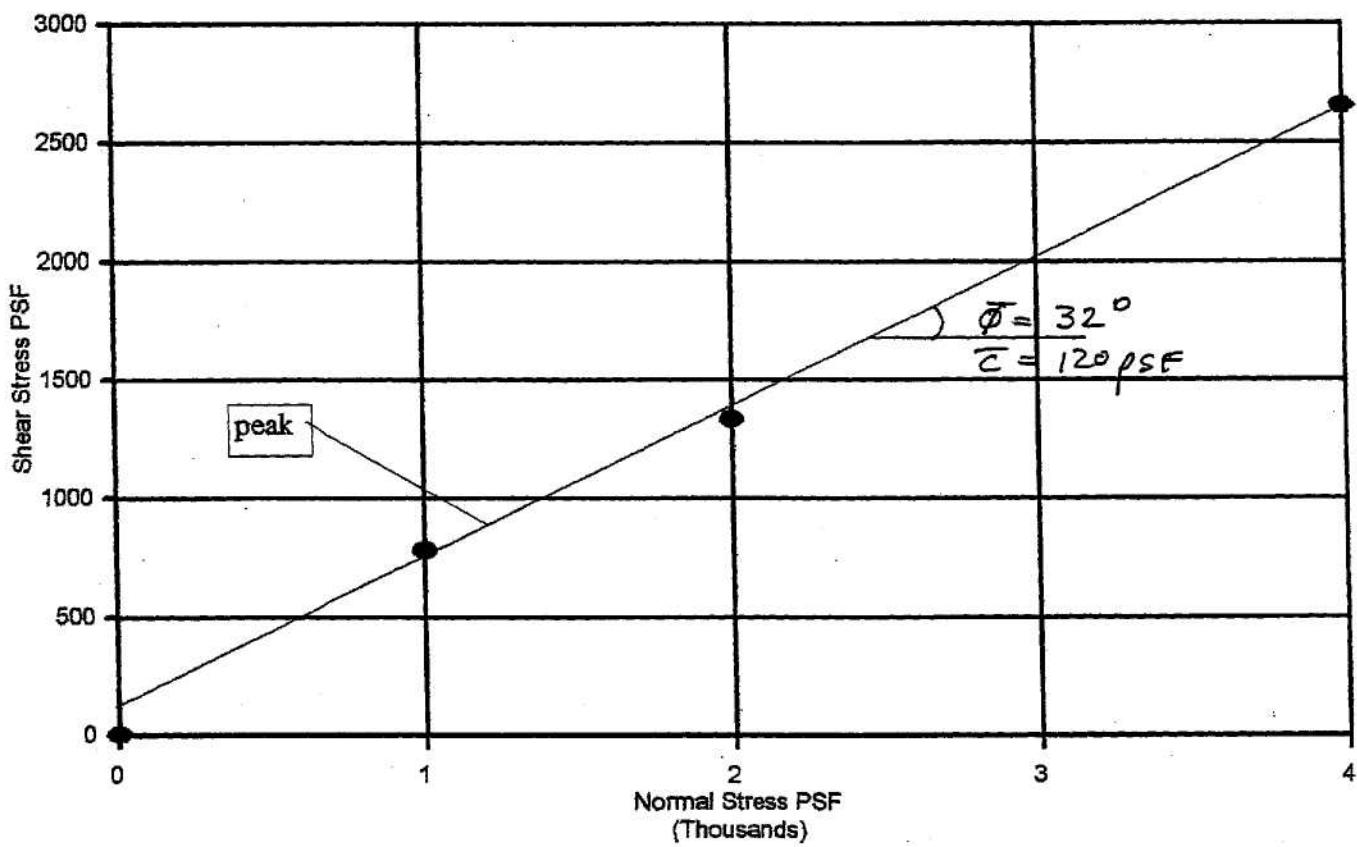
Project: Skyline Mines Discharge Study
Client: Earthfax Engineering
Project #: 401356

LABORATORY SUMMARY

SPECS							
EC-2S							
277							
Baggie							
11/27/01							
Earthfax							
ASTM C136, C566, C117, D4318							
The sample was granular and non-plastic							
1/2"	100.0%						
3/8"	66.8%						
#4	56.6%						
#8	50.4%						
#16	44.9%						
#30	41.1%						
#50	35.3%						
#100	25.5%						
#200	19.7%						

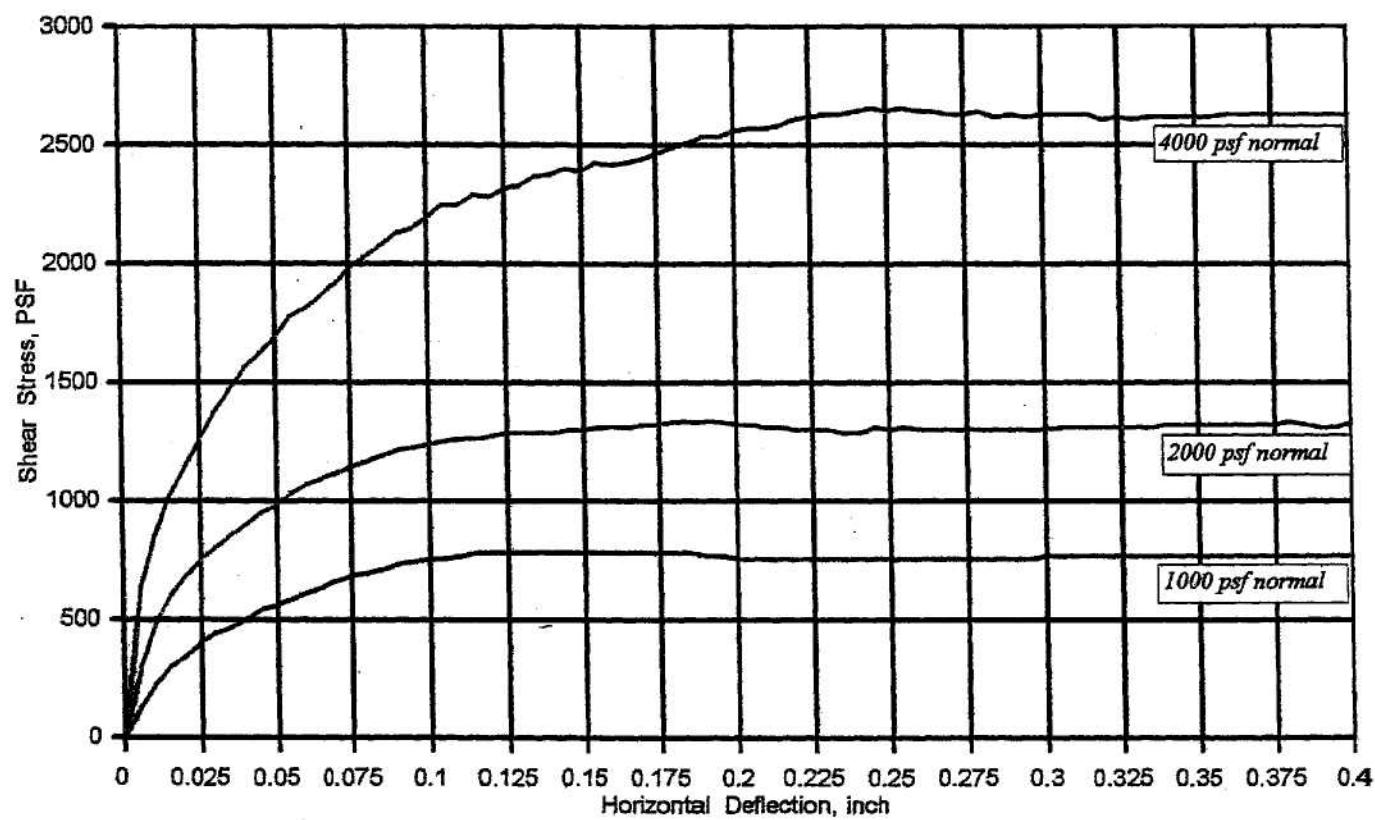
CMT ENGINEERING LABORATORIES

DIRECT SHEAR - Consolidated Drained EC-2 S



Direct Shear

Sample EC-2 S

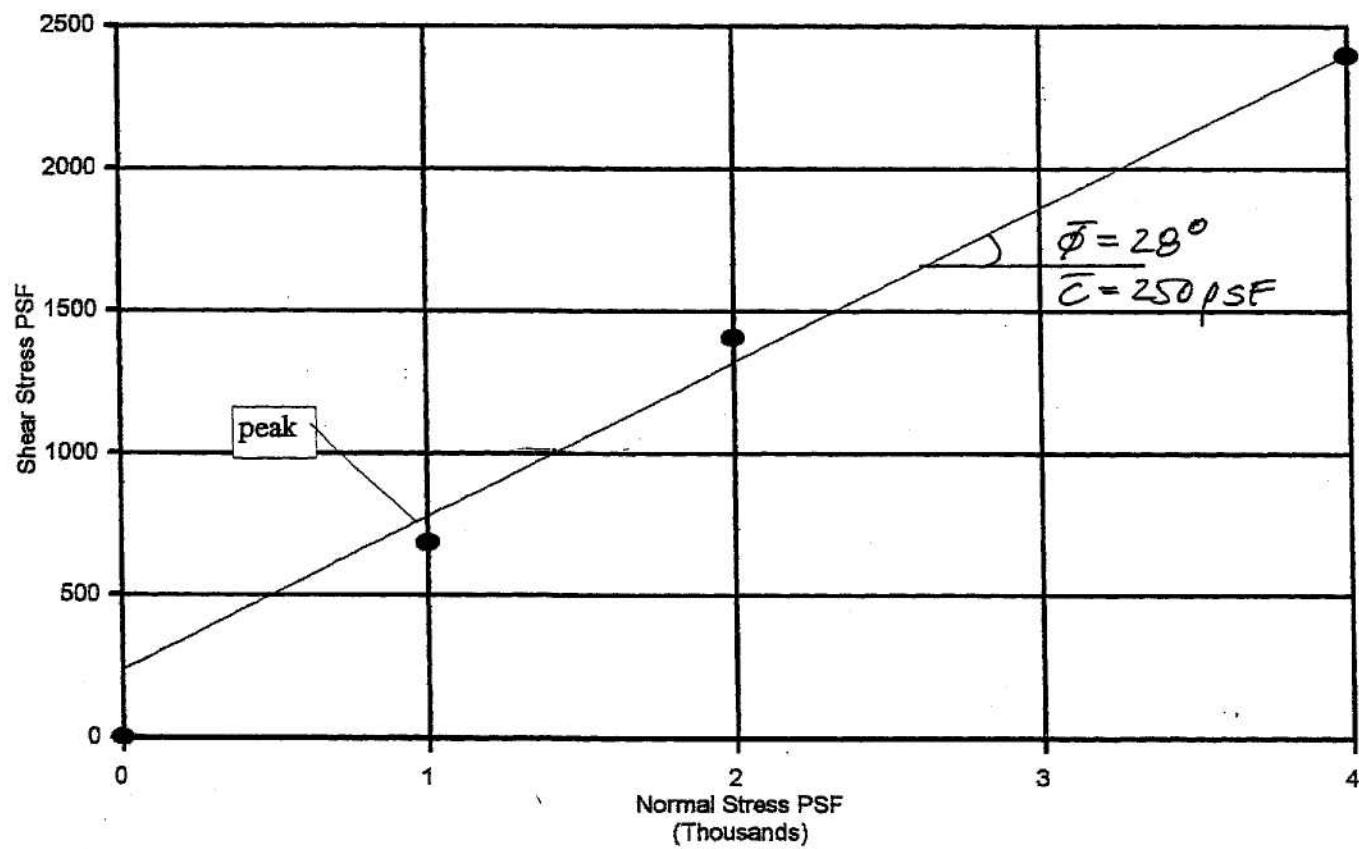


Project: Skyline Mines Discharge Study
Client: Earthfax Engineering
Project #: 401356

LABORATORY SUMMARY

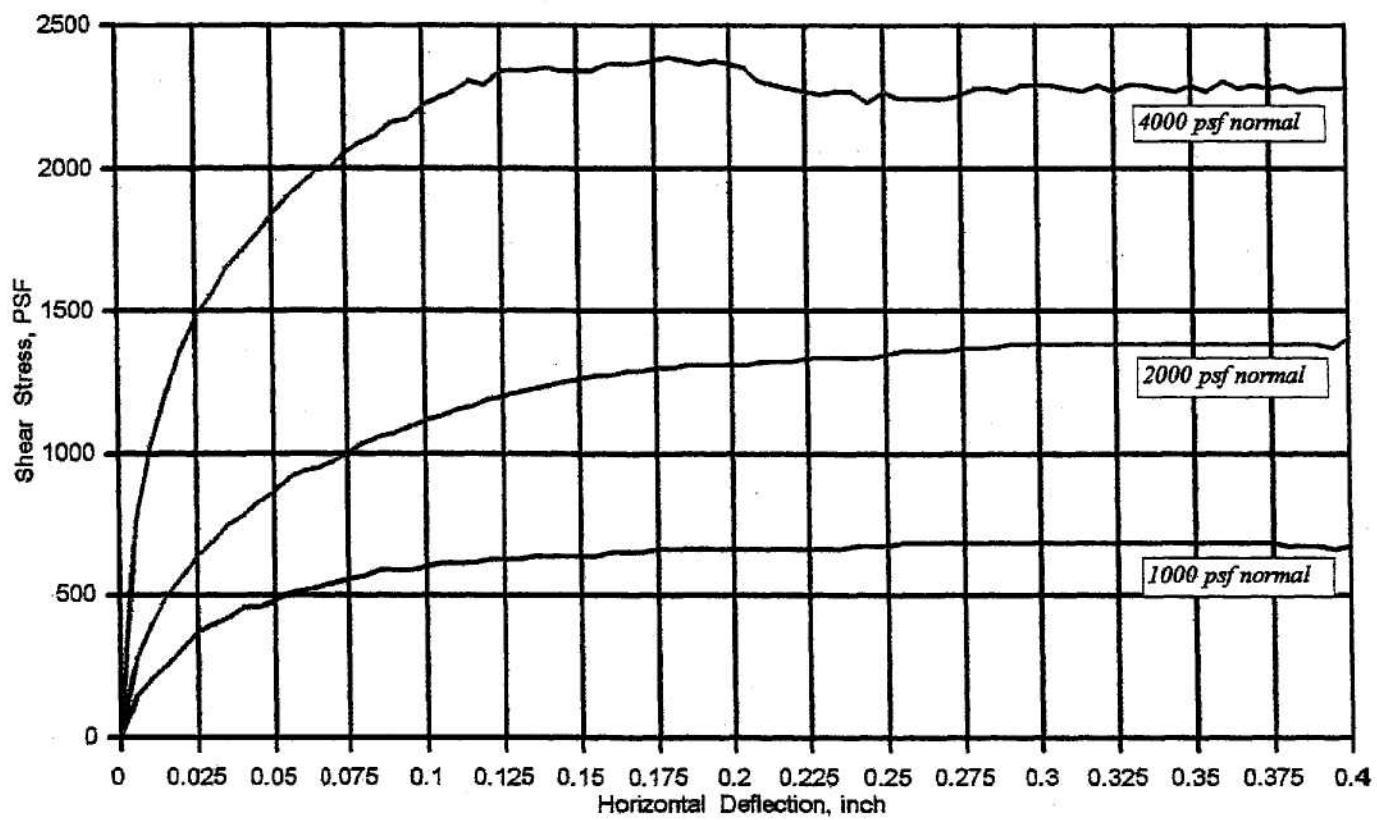
CMT ENGINEERING LABORATORIES

DIRECT SHEAR - Consolidated Drained EC-3 S



Direct Shear

Sample EC-3 S

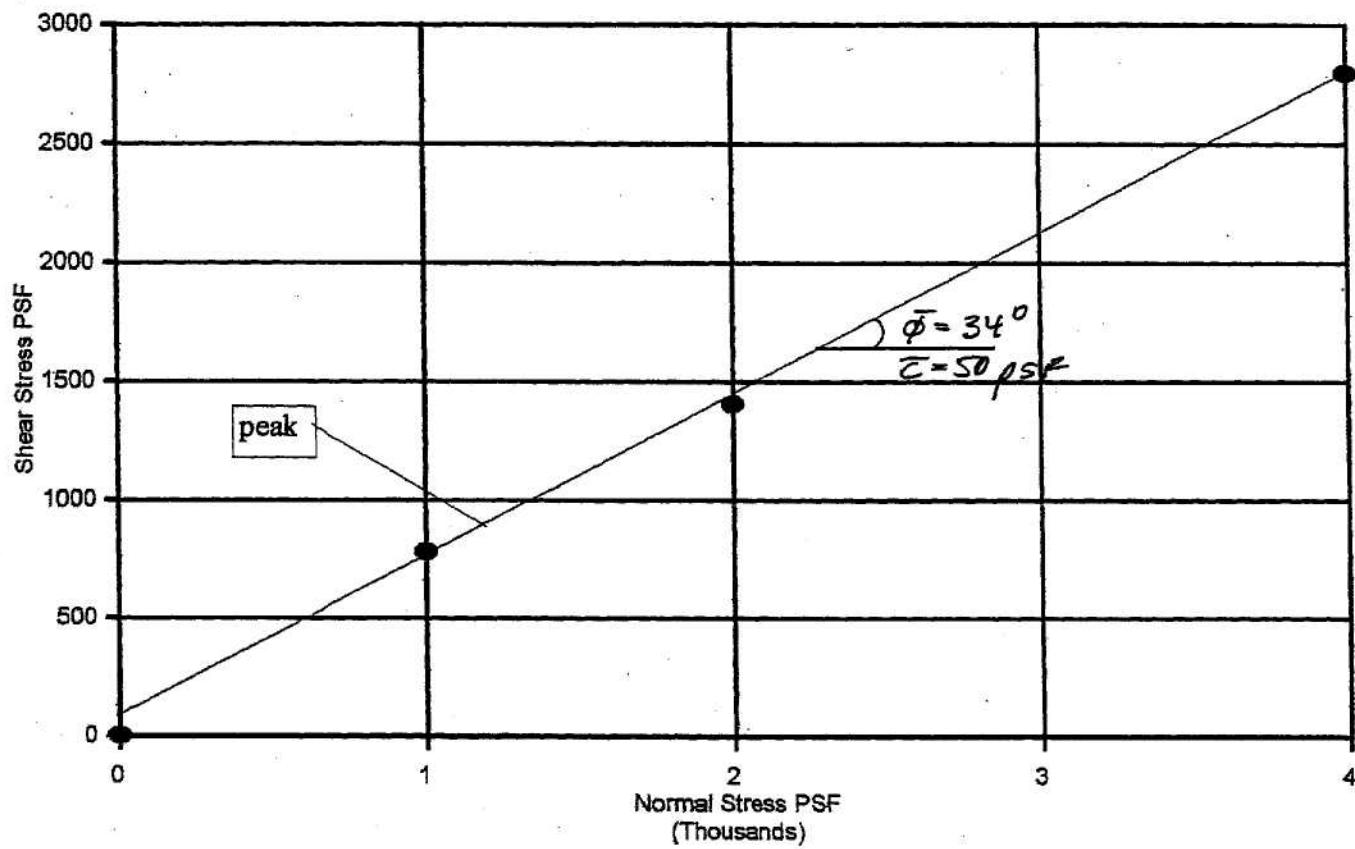


Project: Skyline Mines Discharge Study
Client: Earthfax Engineering
Project #: 401356

LABORATORY SUMMARY

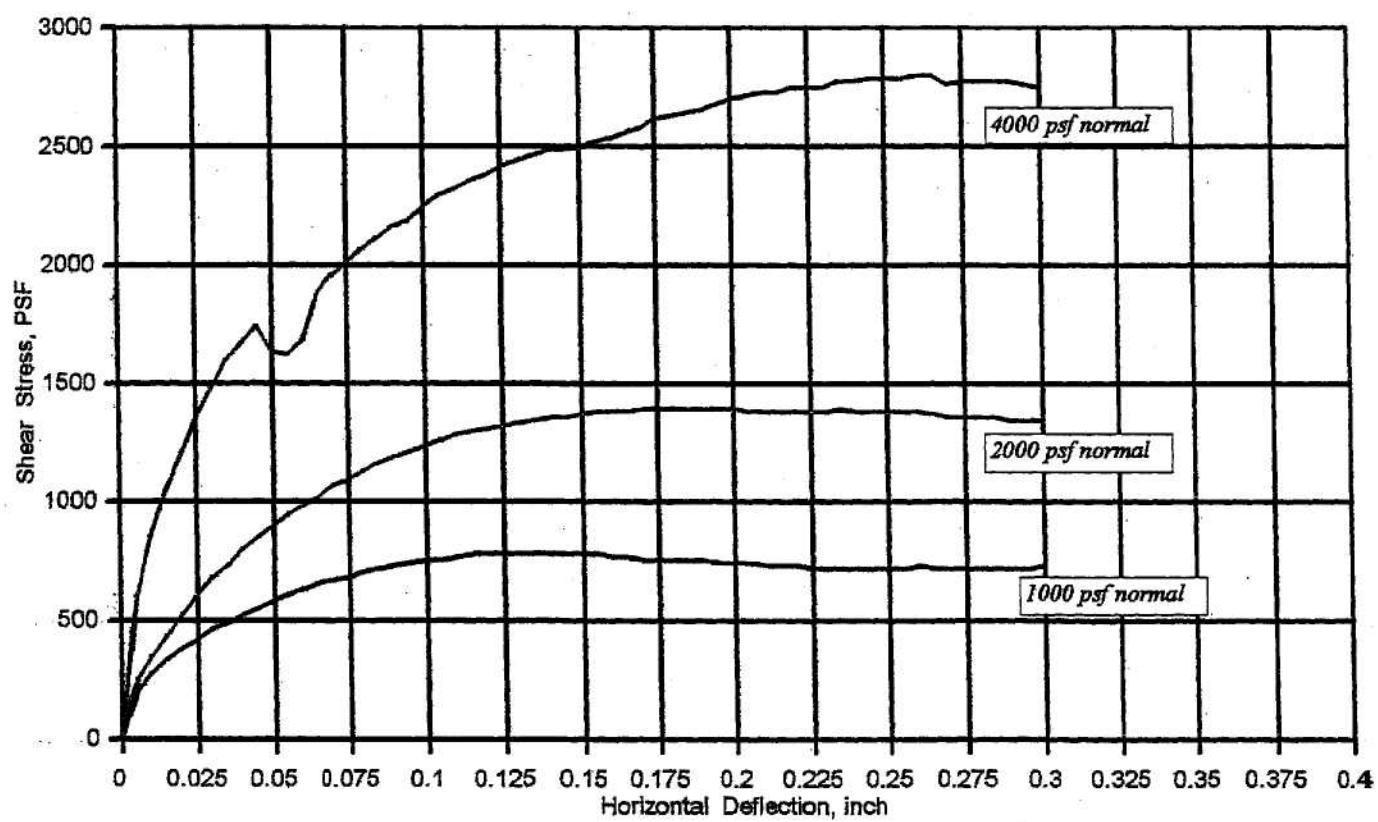
CMT ENGINEERING LABORATORIES

DIRECT SHEAR - Consolidated Drained MC-1 S



Direct Shear

Sample MC-1 S

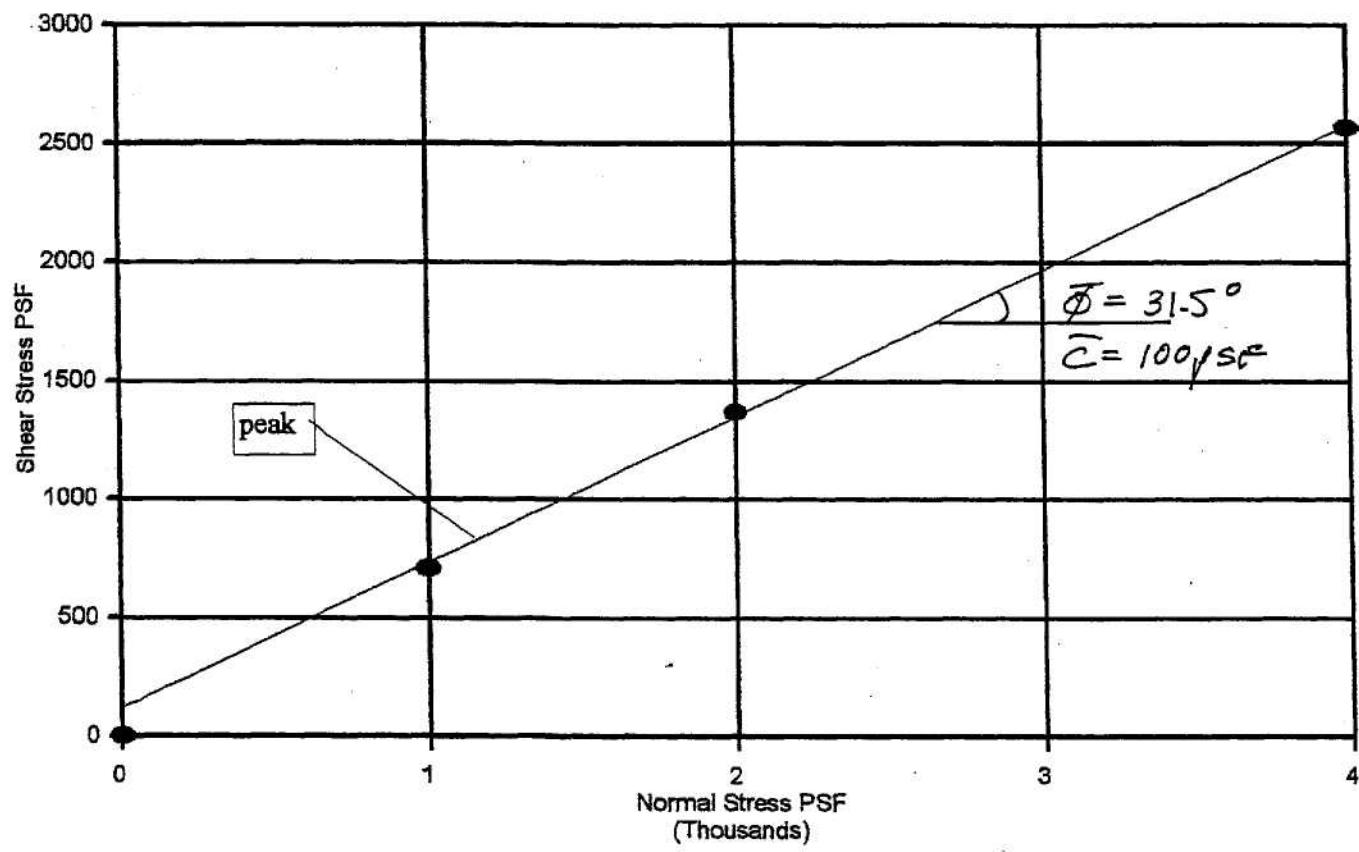


Project: Skyline Mines Discharge Study
Client: Earthfax Engineering
Project #: 401356

LABORATORY SUMMARY

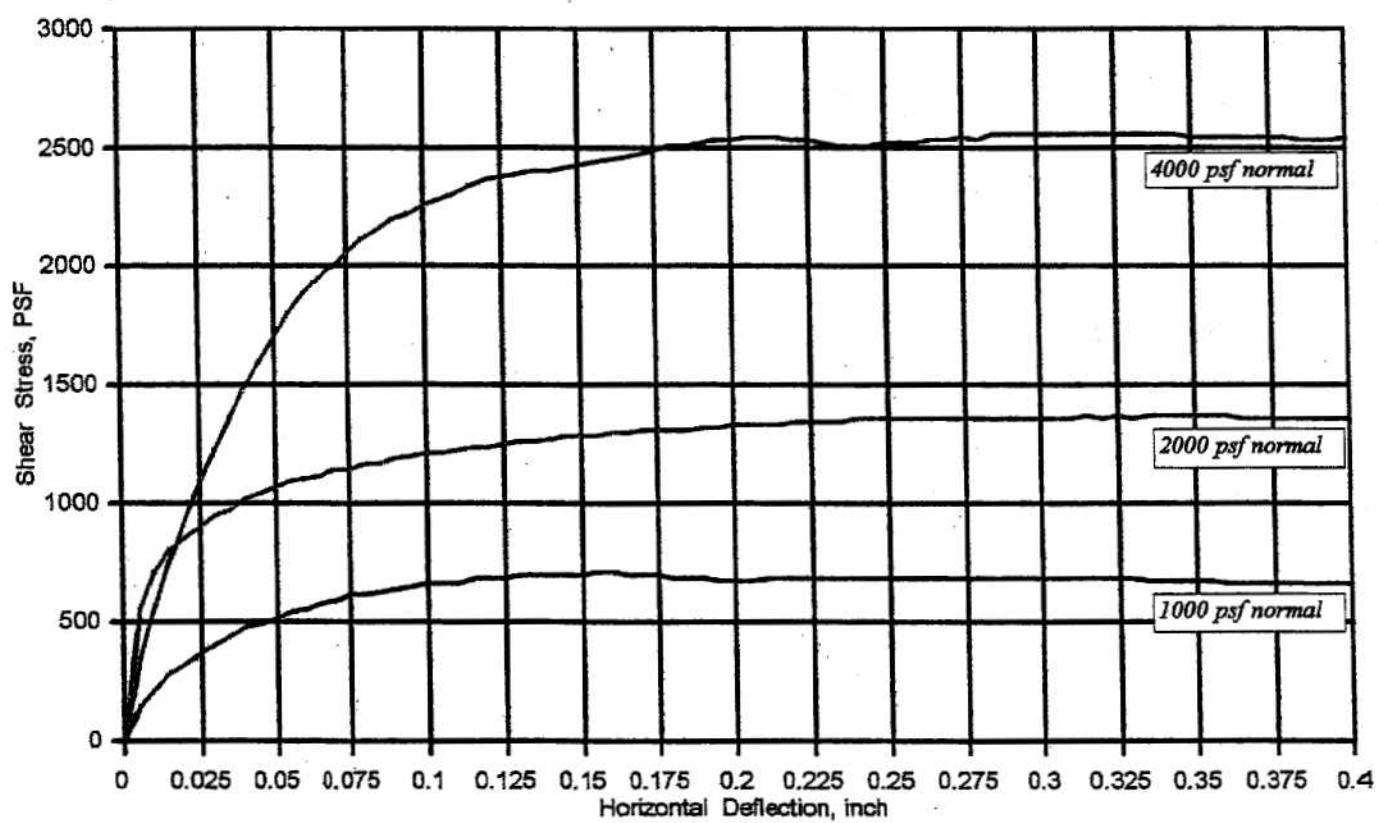
CMT ENGINEERING LABORATORIES

DIRECT SHEAR - Consolidated Drained MC-2 S



Direct Shear

Sample MC-2 S



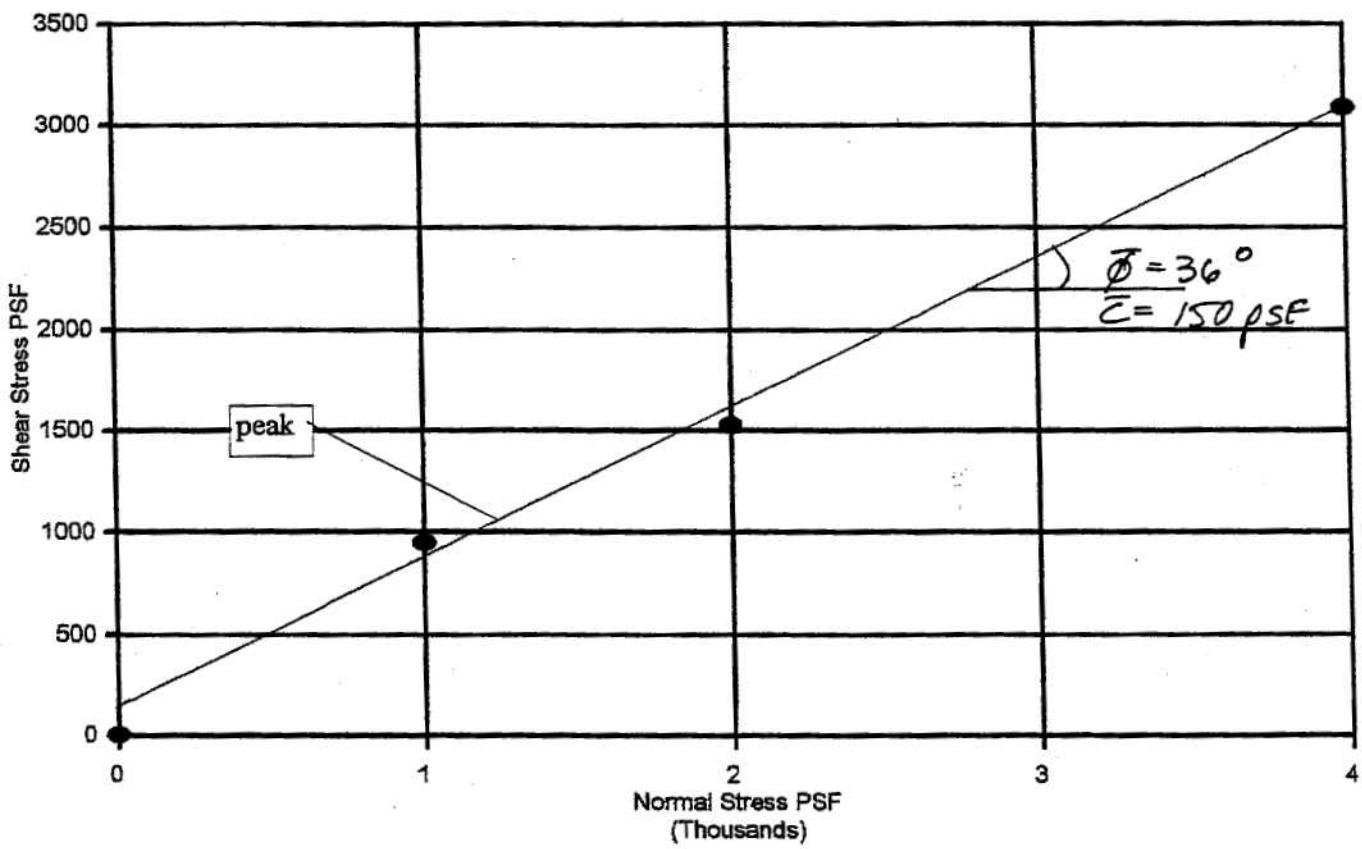
Project: Skyline Mines Discharge Study
Client: Earthfax Engineering
Project #: 401356

LABORATORY SUMMARY

SPECS											
Sample Location		MC-3S									
Laboratory Number		277									
Sample Type		Baggie									
Date Received		11/27/01									
Sampled By		Earthfax									
Method Used		ASTM C136, C566, C117 & D4318									
<u>Plastic Limits</u>		The sample was non-plastic									
<u>GRADING</u>											
S I E V E	%	1/2"	100.0%								
P A S S I N G		3/8"	96.3%								
		#4	93.0%								
		#8	90.6%								
		#16	88.3%								
		#30	84.2%								
		#50	80.0%								
		#100	70.1%								
		#200	54.3%								

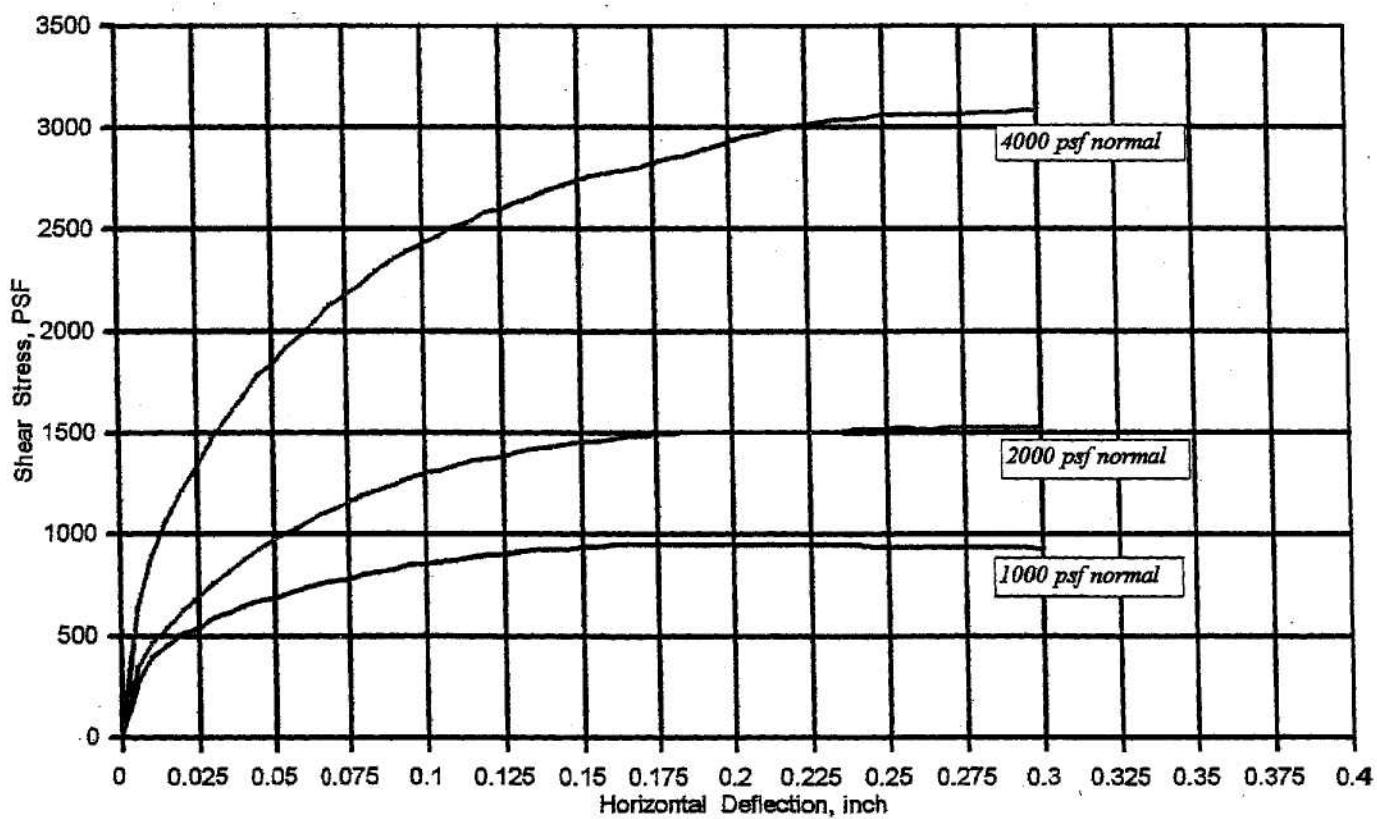
CMT ENGINEERING LABORATORIES

DIRECT SHEAR - Consolidated Drained MC-3 S



Direct Shear

Sample MC-3 S



Project: Skyline Mine Discharge Study (UC-794-02)
Client: Earthfax Engineering
Project #: 401356

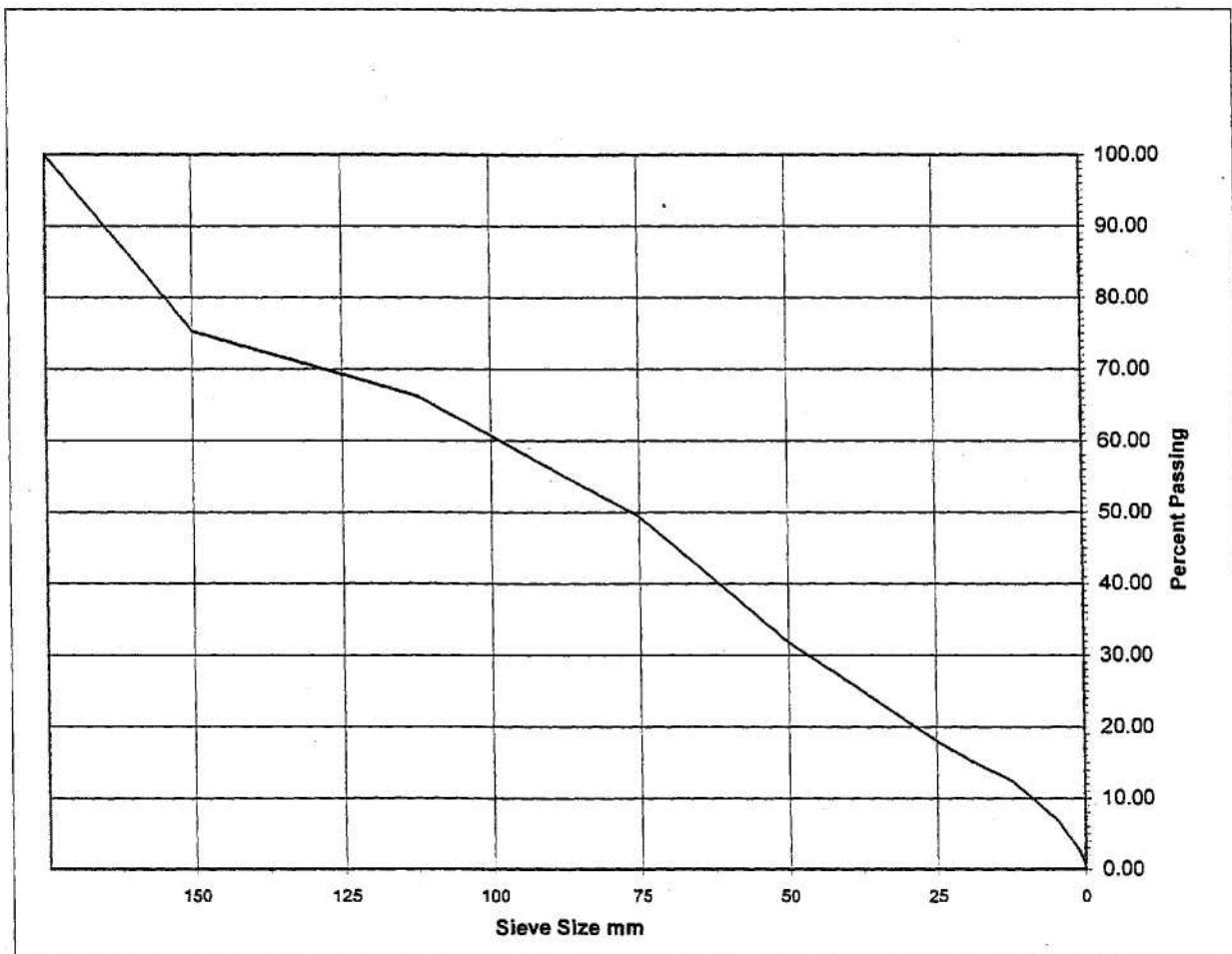
LABORATORY SUMMARY

278				
Bucket				
11/26/01				
ASTM C136, C566 & C117				
EC-3B	MC-3B	MC-2B	MC-1B	EC-1B
100.0%	79.6%	100.0%	100.0%	75.3%
66.1%	N/A	67.8%	81.9%	66.1%
35.3%	66.2%	39.1%	49.7%	49.4%
20.8%	46.0%	21.9%	31.7%	31.8%
20.4%	24.4%	13.2%	23.5%	22.6%
18.3%	17.7%	10.4%	18.1%	18.0%
16.2%	13.4%	8.3%	16.0%	15.1%
13.9%	9.0%	5.9%	12.5%	12.4%
12.3%	7.3%	5.1%	11.5%	10.9%
7.7%	5.0%	3.5%	7.5%	6.8%
5.3%	4.0%	2.6%	5.3%	4.5%
3.0%	3.2%	1.9%	3.4%	2.8%
1.7%	2.6%	1.5%	2.1%	1.8%
1.0%	2.0%	1.1%	1.2%	1.1%
0.4%	1.5%	0.7%	0.8%	0.6%
0.2%	1.1%	0.5%	0.5%	0.3%

CMT ENGINEERING LABORATORIES

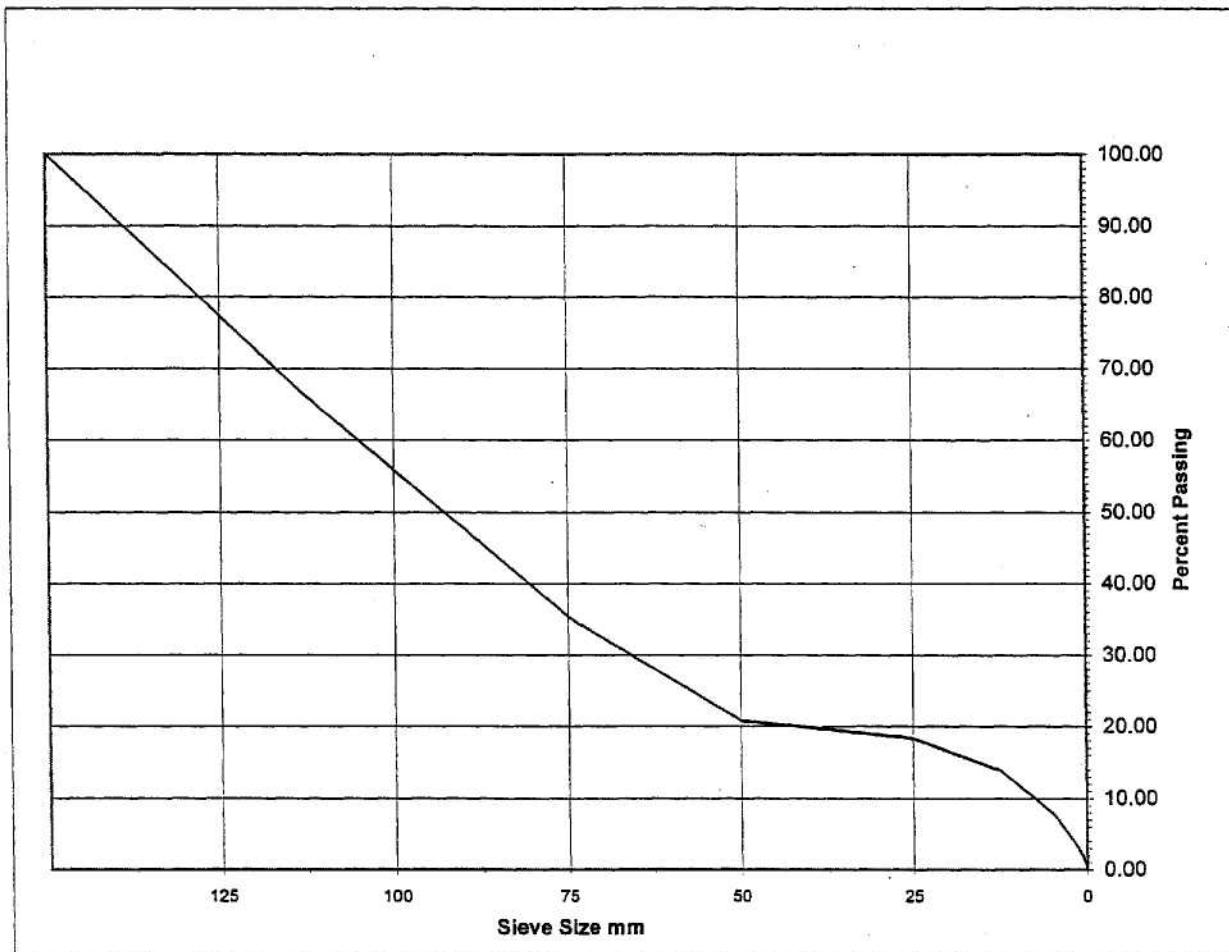
Gradation Curve

Project	Skyline Mine Discharge Study (UC-794-02)	Date	11/26/01
Client	Earthfax Engineering	Project No.	401356
Contractor		Lab No.	278
Soil Description	EC-1B	Tech.	Jeanne Richter
Source		Method	ASTM C 136
Use Of Material			



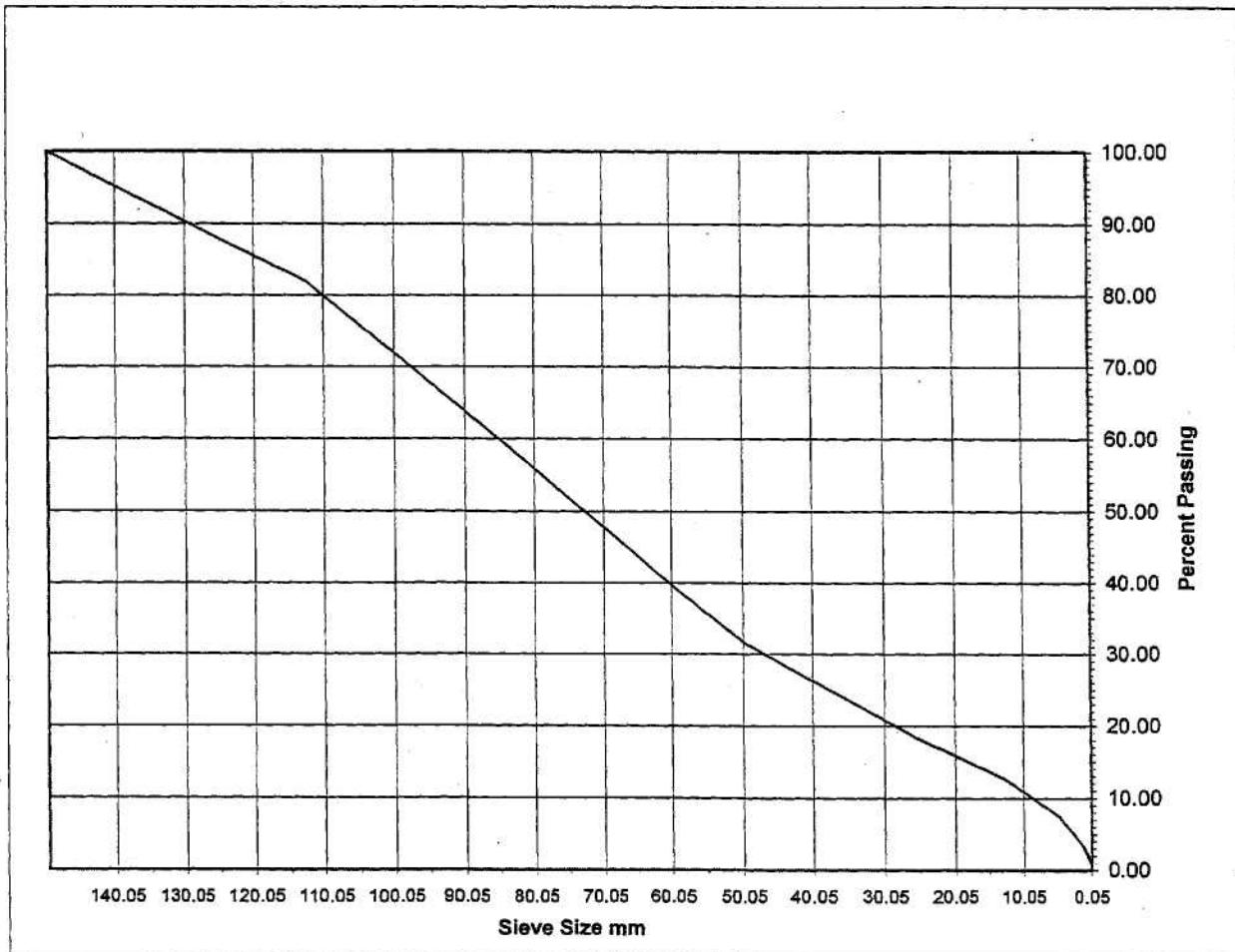
Gradation Curve

Project	<u>Skyline Mine Discharge Study (UC-794-02)</u>	Date	<u>11/26/01</u>
Client	<u>Earthfax Engineering</u>	Project No.	<u>401356</u>
Contractor		Lab No.	<u>278</u>
Soil Description	<u>EC-3B</u>	Tech.	<u>Jeanne Richter</u>
Source		Method	<u>ASTM C 136</u>
Use Of Material			



Gradation Curve

Project	Skyline Mine Discharge Study (UC-794-02)	Date	11/26/01
Client	Earthfax Engineering	Project No.	401356
Contractor		Lab No.	278
Soil Description	MC-1B	Tech.	Jeanne Richter
Source		Method	ASTM C 136
Use Of Material			



Gradation Curve

Project

Skyline Mine Discharge Study (UC-794-02)

Date

11/26/01

Client

Earthfax Engineering

Project No.

401356

Contractor

278

Soil Description

MC-2B

Tech.

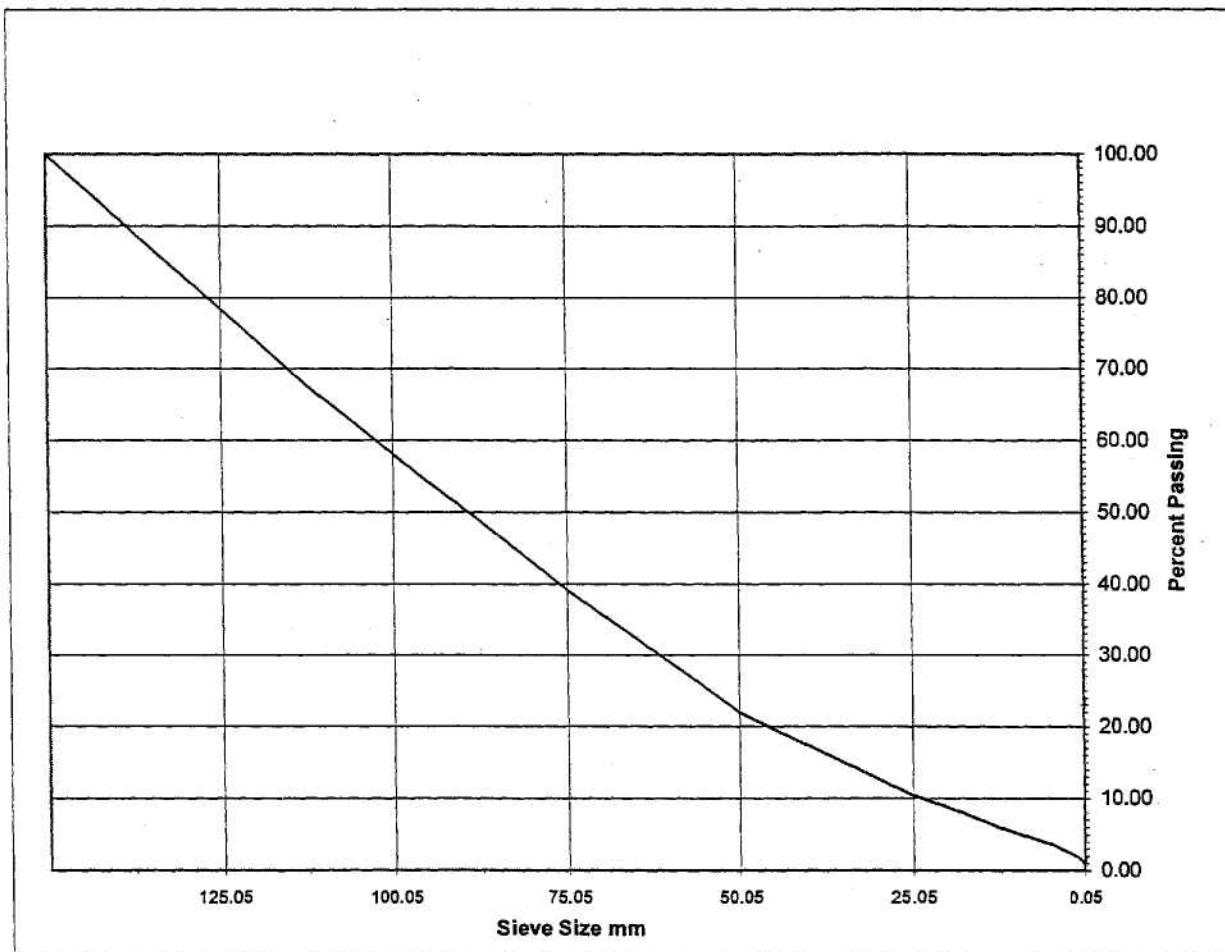
Jeanne Richter

Source

Method

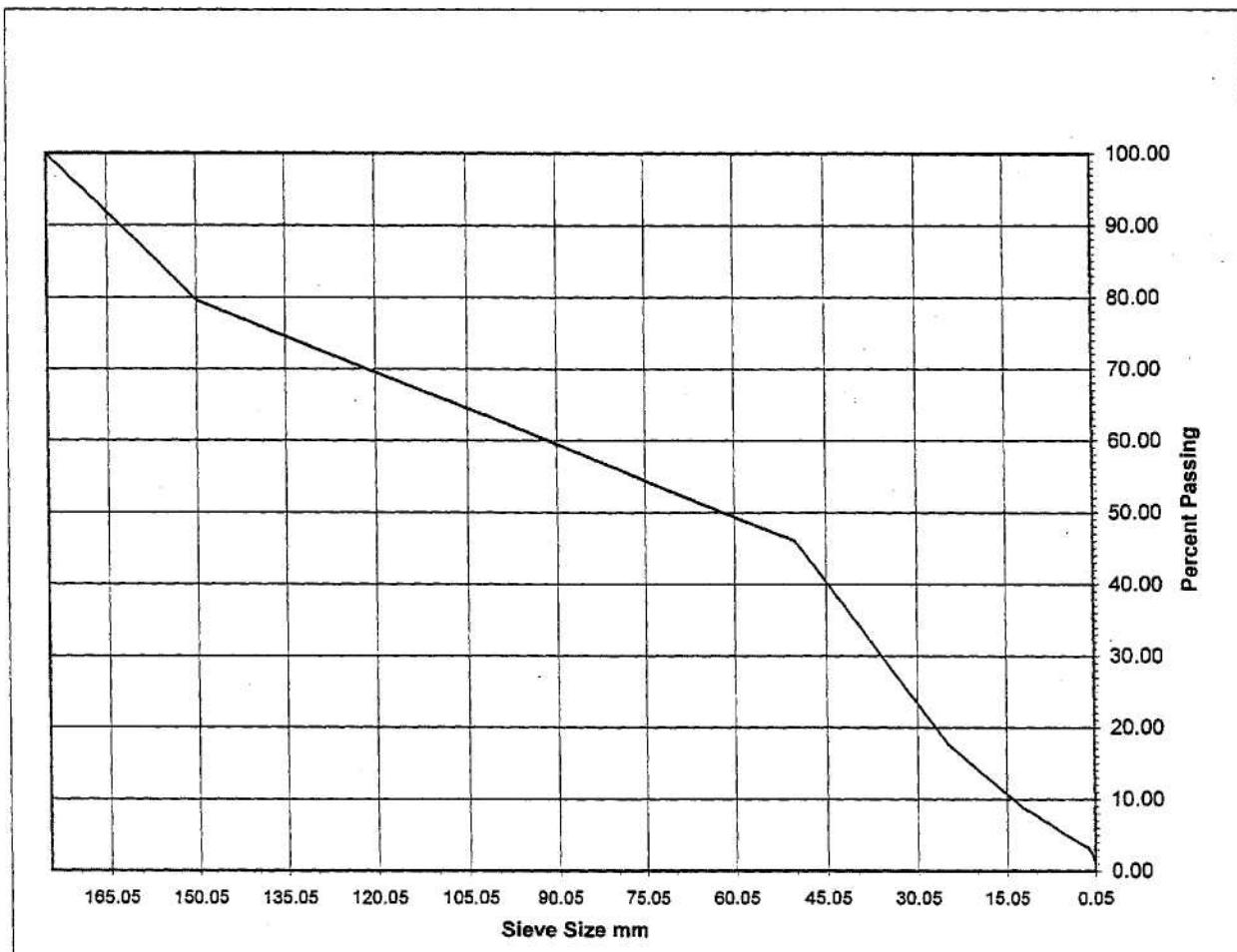
ASTM C 136

Use Of Material



Gradation Curve

Project	<u>Skyline Mine Discharge Study (UC-794-02)</u>	Date	<u>11/26/01</u>
Client	<u>Earthfax Engineering</u>	Project No.	<u>401356</u>
Contractor		Lab No.	<u>278</u>
Soil Description	<u>MC-3B</u>	Tech.	<u>Jeanne Richter</u>
Source		Method	<u>ASTM C 136</u>
Use Of Material			



SOIL SAMPLE ANALYSIS REQUEST

EarthFax Project No.: UC-794-03

Collection Date: 16 Aug 2002

Analytical Laboratory: CMT Engineering Laboratories
215 North Redwood Road
Suite 2
North Salt Lake, Utah 84054
(801)936-1567

Sample No.	Sample Type	Analyses Requested
MC-4D	Grab	Each sample to be analyzed (as appropriate to the sample type) for:
MC-4S	Shelby tube	Dry unit weight
MC-5D	Grab	Direct shear
MC-5S	Shelby tube	Atterberg limits
MC-4SS	Bulk grab	Each sample to be analyzed for gradation by sieve analysis
MC-5SS	Bulk grab	

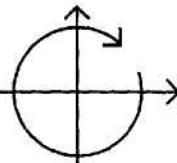
Results to be reported to:

Rich White
EarthFax Engineering, Inc.
7324 South Union Park Ave.
Suite 100
Midvale, UT 84047

Phone: 801-561-1555
Fax: 801-561-1861
e-mail: rbwhite@earthfax.com



CONSTRUCTION MATERIALS TECHNOLOGIES



October 25, 2002

EarthFax Engineering, Inc.
Attn: Rich White
7324 South Union Park Ave.
Suite 100
Midvale, UT 84047

Project #: 0704, Lab Services
Lab #: 4674, 4675
Test Date: 08/21/02
EarthFax Project #: UC-794-03

ATTERBERG LIMITS ASTM D4318/AASHTO T89 & T90

Sample I.D.: MC-4D

Lab # 4674 – MC-4D

Non-Plastic

Sample I.D.: MC-5D

Lab # 4675 – MC-5D

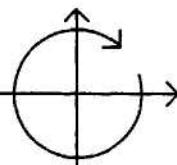
Non-Plastic

Sincerely,

Manager



CONSTRUCTION MATERIALS TECHNOLOGIES



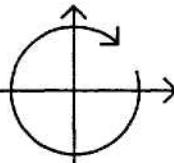
Earthfax Engineering, Inc.
Rich White
7324 South Union Park Ave. Suite #100
Midvale, UT 84047

Project #: 704, Lab Services – UC-794-03
Material: Pit Run
Source: MC-4SS
Lab #: 4677
Test: C-117, 136 Sieve Analysis

<u>Sieve #</u>	<u>% Passing</u>
5"	93
4"	93
3"	85
2"	76
1-1/2"	64
1"	50
3/4"	41
1/2"	32
3/8"	28
#4	23
#8	21
#16	18
#30	14
#50	9
#100	6
#200	3.2

Sincerely,

Manager



Earthfax Engineering, Inc.
Rich White
7324 South Union Park Ave. Suite #100
Midvale, UT 84047

Project #: 704, Lab Services – UC-794-03
Material: Pit Run
Source: MC-5SS
Lab #: 4676
Test: C-117, 136 Sieve Analysis

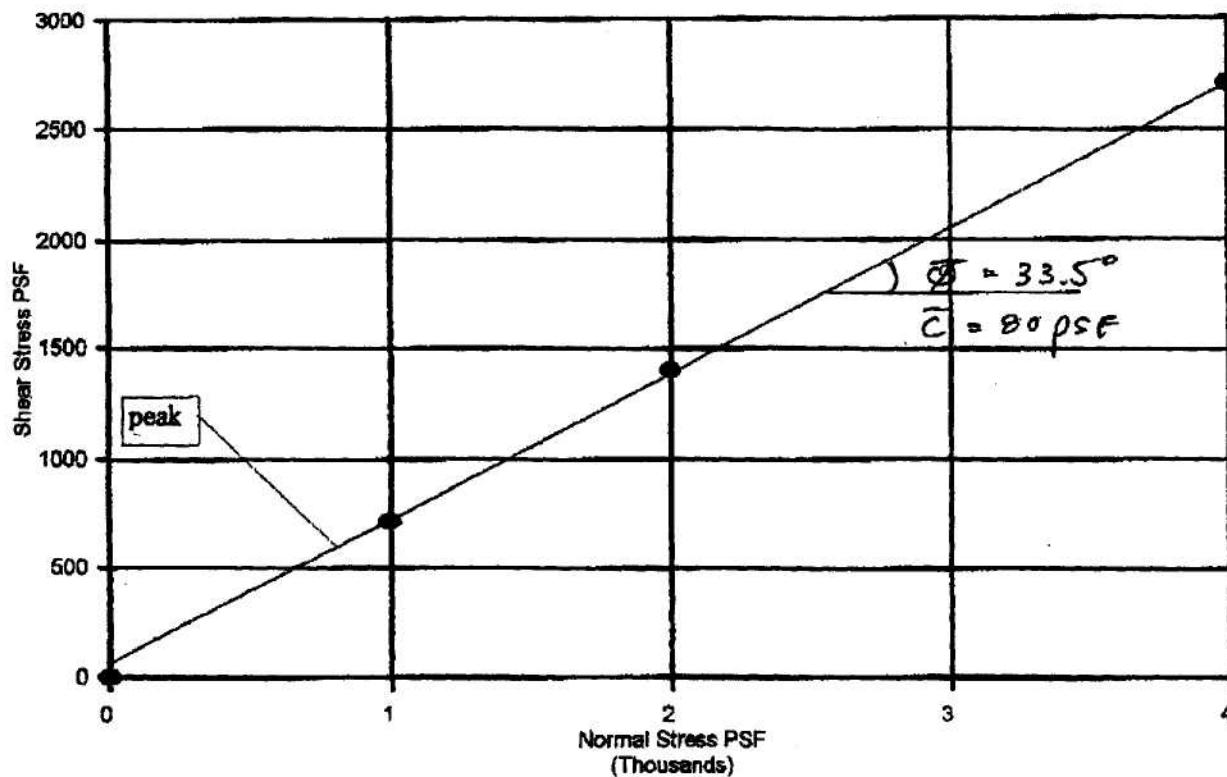
<u>Sieve #</u>	<u>% Passing</u>
5"	100
4"	82.6
3"	57
2 1/2"	38
2"	22.2
1-1/2"	17.3
1"	10.3
3/4"	7.6
1/2"	4.9
3/8"	4.1
#4	2.9
#8	2.4
#16	2
#30	1.6
#50	1.2
#100	0.8
#200	0.5

Sincerely,

Manager

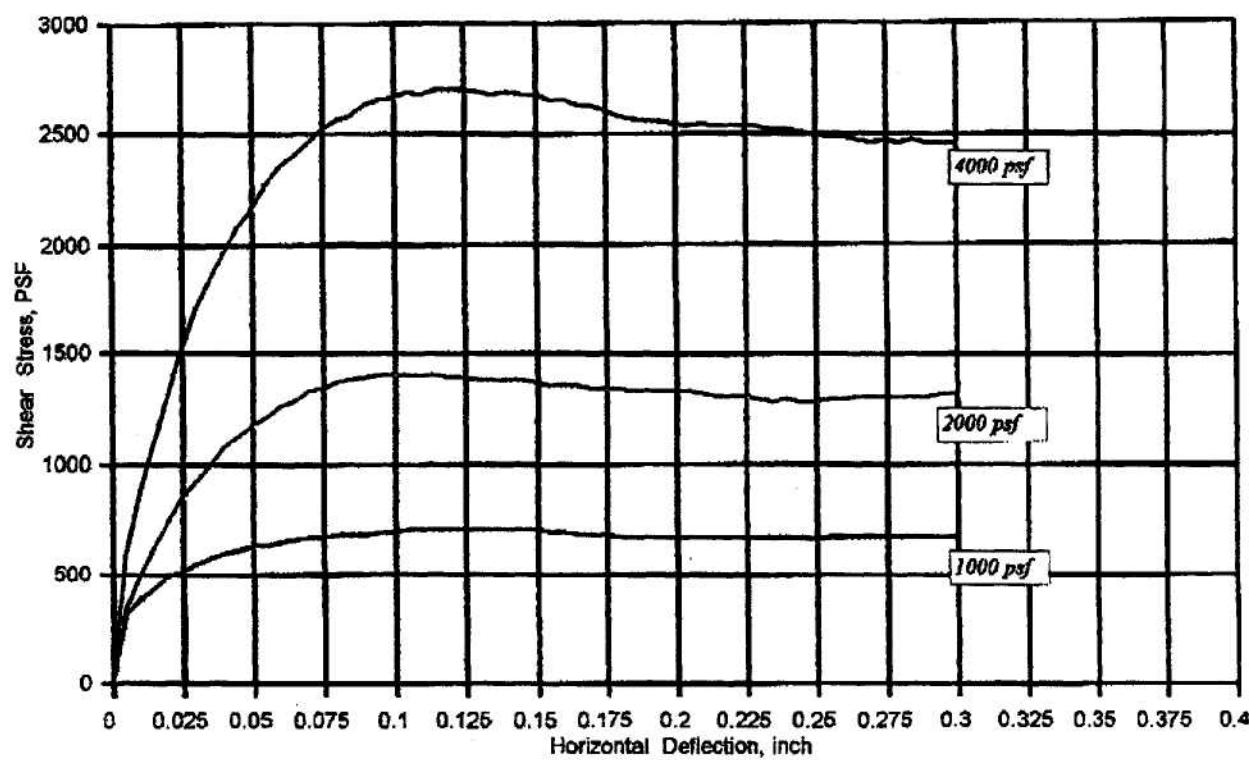
DIRECT SHEAR - Consolidated Drained

CMT, Boring MC-5, collected 8/14/02



Direct Shear

CMT, Boring MC-5



DIRECT SHEAR TEST DATA

ASTM D 3080



PROJECT CMLT PROJECT NUMBER: _____ LOCATION EARTHFAK
 BORING NO. MC-5 SAMPLE NO. 8/14/02 DEPTH (FT) 1000 TYPE OF TEST CD
 SOIL IDENTIFICATION _____ TESTED BY EGI 10/22/02

GENERAL DATA

	INITIAL	FINAL
SAMPLE HEIGHT (in.)	<u>1.000</u>	<u>.9978</u>
SAMPLE DIAMETER (in.)	<u>2.456</u>	
SAMPLE AREA (in. ²)	<u>4.582</u>	
SAMPLE VOLUME (in. ³)		

VOID RATIO COMPUTATION

VOLUME TOTAL - V_t (cc)	_____
VOLUME OF SOLID - V_s (cc)	_____
VOLUME OF VOID - V_v (cc)	_____
VOID RATIO - e	_____
DEGREE OF SATURATION (%)	_____

MOISTURES & DENSITIES

SAMPLE WET WEIGHT & TARE (gms)	<u>176.85</u>
WEIGHT OF TARE (gms)	<u>46.74</u>
SAMPLE WET WEIGHT NET (gms)	<u>130.11</u>
WET DENSITY (pcf)	<u>108.1</u> <u>108.5</u>

SHEAR STRENGTH SUMMARY

	PEAK	ULTIMATE
HORIZONTAL DEFORMATION (in.)	_____	_____
SHEAR STRESS (psf)	_____	_____

TARE NO. E

WET WEIGHT & TARE (gms)	<u>151.55</u>
DRY WEIGHT & TARE (gms)	<u>122.80</u>
WEIGHT OF WATER (gms)	_____
WEIGHT OF TARE (gms)	<u>21.24</u>
WEIGHT OF DRY SOIL (gms)	<u>101.6</u>
WATER CONTENT (%)	<u>28.1</u> <u>28.3</u>
DRY DENSITY - γ_d (pcf)	<u>84.4</u> <u>84.6</u>

$$\gamma_d = \gamma_d' (V_s / V_t) =$$

REMARKS: _____

1000 7202000 14044000 2708

$$\theta = 33.5^\circ$$

$$C = 80 \text{ psf}$$

SI-10-22

SPECIFIC GRAVITY _____

- ASSUMED
 DETERMINED

THE DATA IN THIS GROUP
 ARE CHECKED AND IN ORDER BY EGI

- Approved for submission
 Disapproved for submission
 Hold for further action

COMMENTS: _____

BY _____ / /

SHEARING RATE DETERMINATION

$$t_{90} = \text{min.}$$

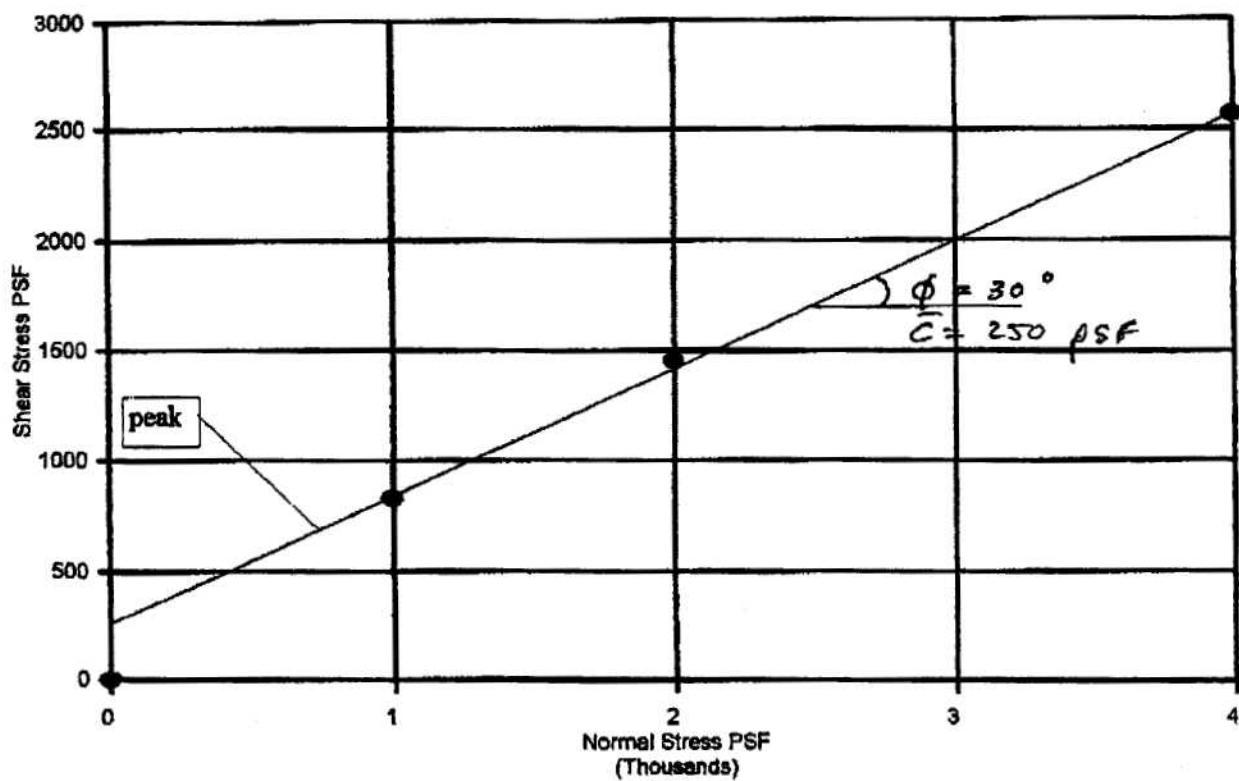
$$12t_{90} = \text{min.} = t_{failure}$$

ESTIMATED HORIZONTAL

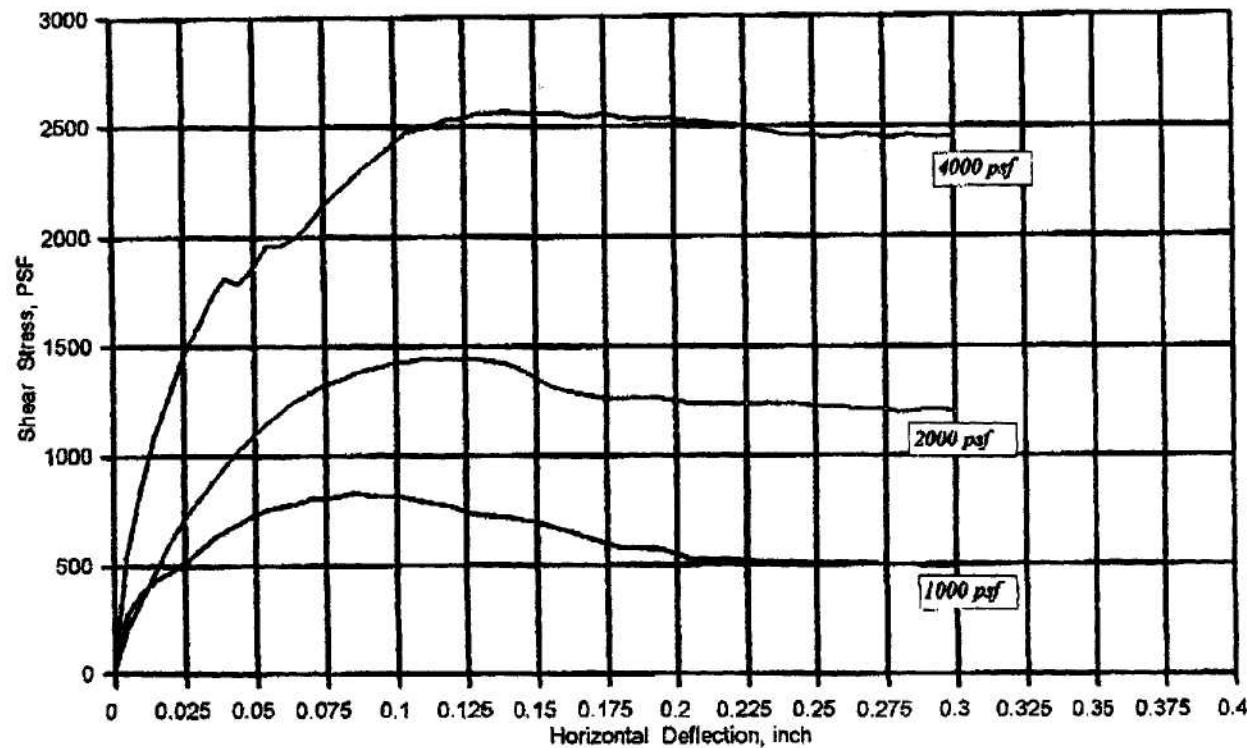
DEFORMATION AT FAILURE (D_f) = _____ in.S.R. = $D_f / 12t_{90}$ = _____ in./min.

DIRECT SHEAR - Consolidated Drained

CMT, Boring MC-4S, collected 8/14/02



Direct Shear
CMT, Boring MC-4S



DIRECT SHEAR TEST DATA

ASTM D 3080

PROJECT CMT PROJECT NUMBER: _____ LOCATION EARTHAXBORING NO. MC - 4S SAMPLE NO. 8/14/02 DEPTH (FT) 1600 TYPE OF TEST CDSOIL IDENTIFICATION SP/SM TR ROOTS TESTED BY EL DATE 10/21/02**GENERAL DATA**

	INITIAL	FINAL
SAMPLE HEIGHT (in.)	<u>1.000</u>	<u>.9997</u>
SAMPLE DIAMETER (in.)	<u>2.416</u>	
SAMPLE AREA (in. ²)	<u>4.582</u>	
SAMPLE VOLUME (in. ³)		

VOID RATIO COMPUTATION

VOLUME TOTAL -- V _t (cc)	_____
VOLUME OF SOLID -- V _s (cc)	_____
VOLUME OF VOID -- V _v (cc)	_____
VOID RATIO -- e	_____
DEGREE OF SATURATION (%)	_____

MOISTURES & DENSITIES

SAMPLE WET WEIGHT & TARE (gms)	<u>191.93</u>
WEIGHT OF TARE (gms)	<u>45.97</u>
SAMPLE WET WEIGHT NET (gms)	<u>145.96</u>
WET DENSITY (pcf)	<u>121.2</u>
	<u>120.5</u>

shear strength summary

	PEAK	ULTIMATE
HORIZONTAL DEFORMATION (in.)	_____	_____
SHEAR STRESS (psf)	_____	_____

TARE NO. I

WET WEIGHT & TARE (gms)	<u>166.52</u>
DRY WEIGHT & TARE (gms)	<u>136.68</u>
WEIGHT OF WATER (gms)	_____
WEIGHT OF TARE (gms)	<u>22.95</u>
WEIGHT OF DRY SOIL (gms)	<u>113.8</u>
WATER CONTENT (%)	<u>28.2</u>
DRY DENSITY - γ_d (pcf)	<u>94.5</u>
$\gamma_d = \gamma_w (V_s / V_t) =$	<u>95.5</u>

REMARKS:

<u>1000</u>	<u>828</u>
<u>2000</u>	<u>1452</u>
<u>4000</u>	<u>2568</u>

$\phi = 30^\circ$

$c = 250 \text{ psf}$

SI - 10 - 21

SPECIFIC GRAVITY _____ ASSUMED
 DETERMINEDTHE DATA IN THIS GROUP
ARE CHECKED AND IN ORDER BY EL

- Approved for submission
 Disapproved for submission
 Hold for further action

shearing rate determination $t_{90} =$ min. $12t_{90} =$ min. = t_{max}

COMMENTS: _____

estimated horizontaldeformation at failure (D_s) = in. $S.R. = D_s / 12t_{90} =$ in./min.

BY _____ / _____ / _____

SOIL SAMPLE ANALYSIS REQUEST

EarthFax Project No.: UC-794-03

Collection Date: 22 Nov 2002

Analytical Laboratory: AGEC
600 West Sandy Parkway
Sandy, UT 84070
Phone: 566-6399

Sample No.	Sample Type	Analyses Requested
MC-6	Grab (ziplock)	Atterberg limits
	Shelby tube	Direct shear, dry unit weight
	Bulk grab (bucket)	Gradation by sieve analysis

Results to be reported to:

Rich White
EarthFax Engineering, Inc.
7324 South Union Park Ave.
Suite 100
Midvale, UT 84047

Phone: 801-561-1555
Fax: 801-561-1861
e-mail: rbwhite@earthfax.com



Applied Geotechnical Engineering Consultants, Inc.

January 15, 2003

Earthfax Engineering
7324 South 1300 East, Suite 100
Midvale, UT 84047

Attention: Rich White
Fax No. 561-1861

Subject: Geotechnical Laboratory Testing
EarthFax Project No. UC-794-03
AGEC Project No. 1020023

Gentlemen:

Applied Geotechnical Engineering Consultants, Inc., was requested to conduct laboratory testing on 3 samples received in our laboratory on November 11, 2002. These samples(bucket, bag, and shelby tube) were all identified as MC-6. Laboratory testing was performed in general accordance with the following test methods.

Test	Test Method
Moisture Content	ASTM D 2216
Dry Density	ASTM D 2937
Sieve Analysis	ASTM C 136
Atterberg Limits	ASTM D 4318
Direct Shear	ASTM D 3080

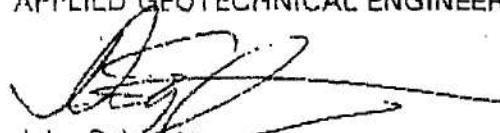
The sieve analysis was performed on the bucket sample. The Atterberg limits were performed on the bag sample. Moisture content, dry density and direct shear testing were performed on the shelby tube sample.

The sieve analysis is presented graphically on Figure 1. The moisture content, dry density and direct shear results are presented on Figure 2. The results of the atterberg limits test indicate a liquid limit of 33% and a plasticity index of 11%.

If we can be of further assistance, please do not hesitate to call.

Sincerely,

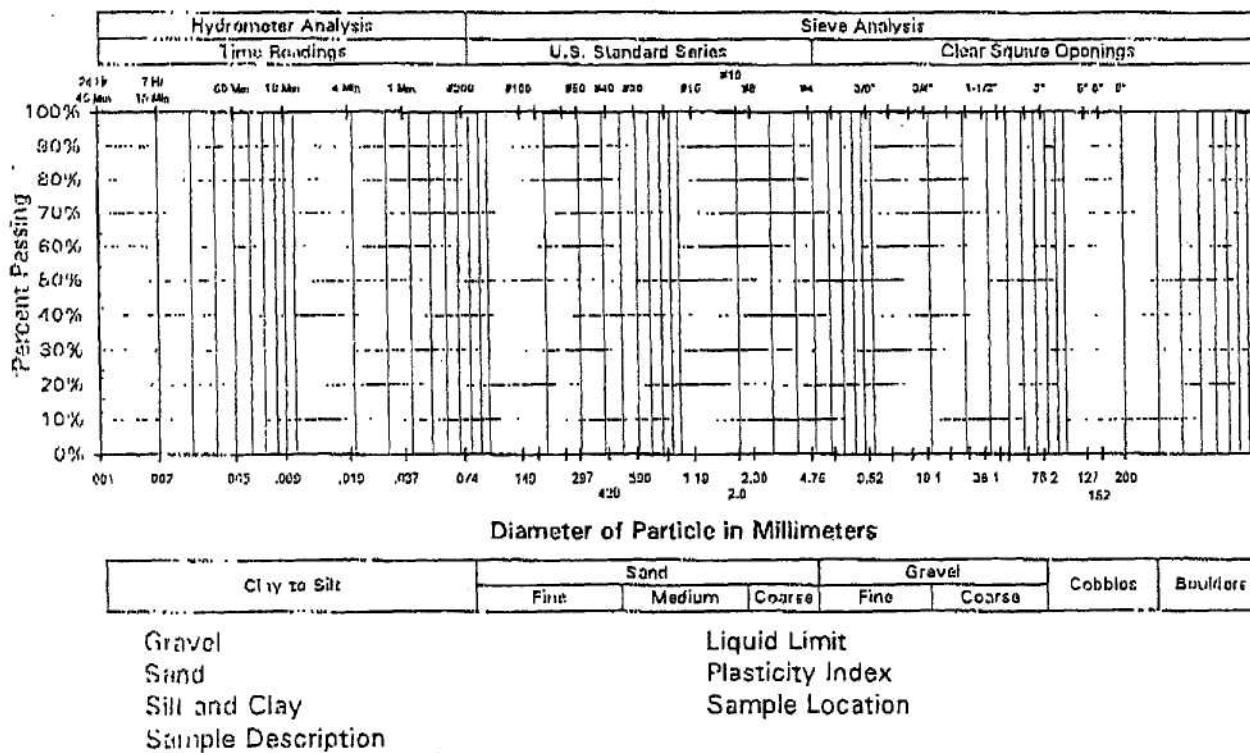
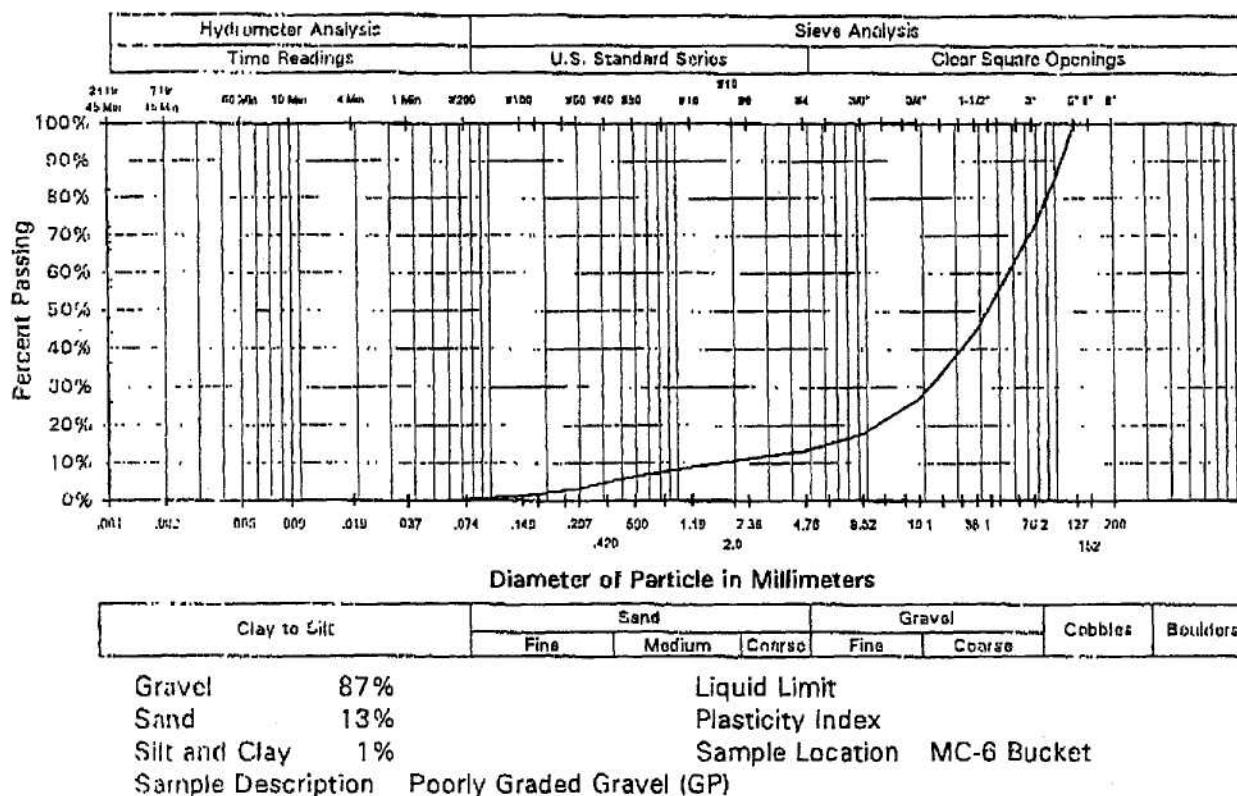
APPLIED GEOTECHNICAL ENGINEERING CONSULTANTS, INC.



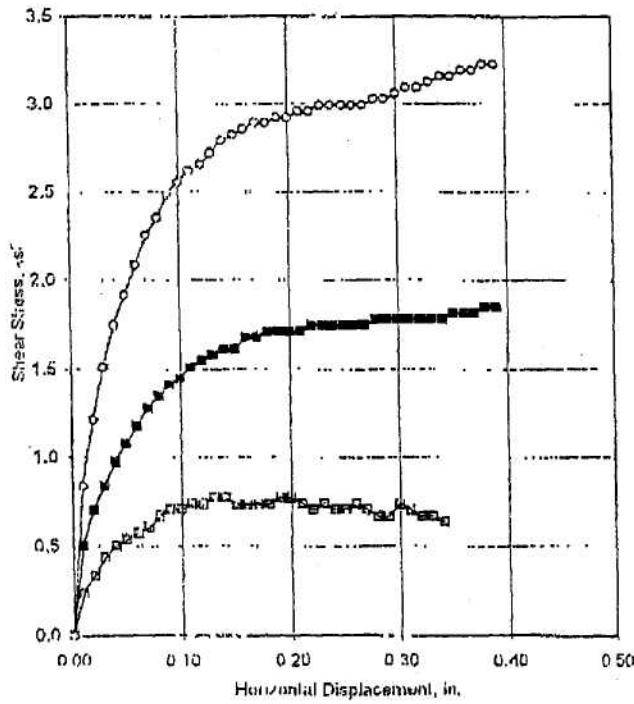
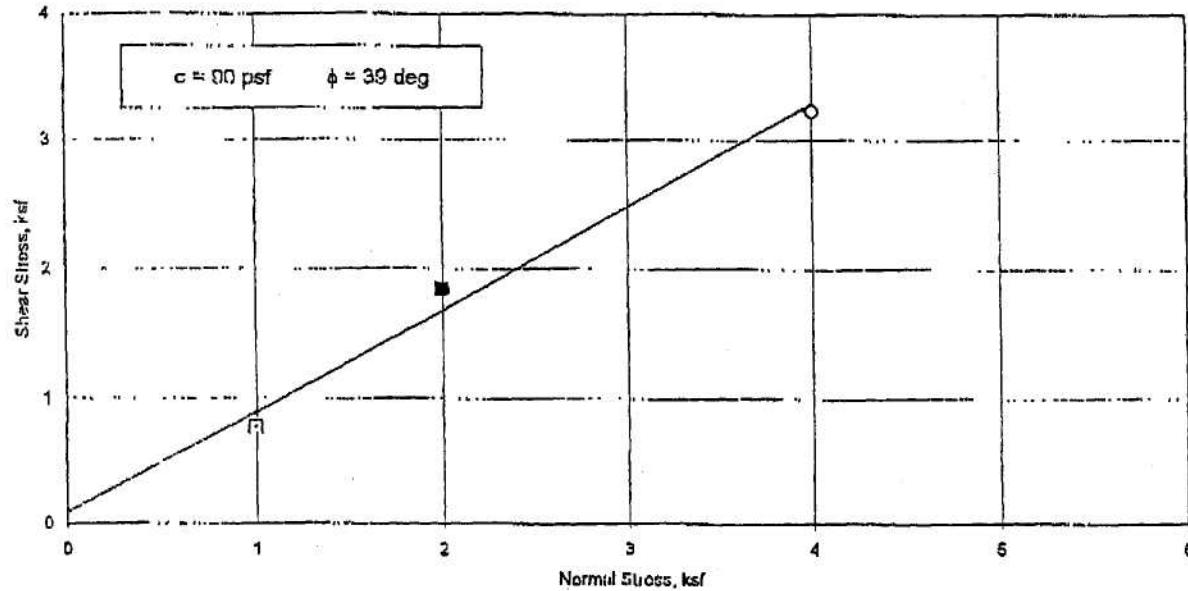
John Sylvester

Reviewed by SDA, P.E.

APPLIED GEOTECHNICAL ENGINEERING CONSULTANTS, INC.



Applied Geotechnical Engineering Consultants, Inc.



Test No. (Symbol)	1(□)	2(■)	3(○)
Sample Type	Undisturbed		
Length, in.	1.00	1.00	1.00
Diameter, in.	1.93	1.93	1.93
Dry Density,pcf	N/A	N/A	N/A
Moisture Content, %	N/A	N/A	N/A
Consolidation Load, ksf	1.0	2.0	1.0
Normal Load, ksf	1.0	2.0	4.0
Shear Stress, ksf	0.77	1.85	3.23
Remarks	Strain Ratio 0.05 in/min.		

Sample Index Properties	
Dry Density,pcf	56
Moisture Content, %	71
Liquid Limit, %	N/A
Plasticity index, %	N/A
Percent Gravel	N/A
Percent Sand	N/A
Percent Passing No. 200 Sieve	N/A

Type of Test:
Sample Description:

Consolidated, Wetted
Clayey Sand with organics

From MC-6 Shelby Tube

Project No. 1020023

Direct Shear Test Results

Figure 2

Canyon Fuel Company
Skyline Mine

Mine-Water Discharge Impact
December 2002

APPENDIX D

Water Quality Data Sheets



COMMERCIAL TESTING & ENGINEERING CO.

GENERAL OFFICES: 1919 SOUTH HIGHLAND AVE., SUITE 210-B, LOMBARD, ILLINOIS 60148 • TEL: 630-953-9300 FAX: 630-953-9306



Member of the SGS Group (Société Générale de Surveillance)

ADDRESS ALL CORRESPONDENCE TO:
P.O. BOX 1020
HUNTINGTON, UT 84528
TEL: (435) 653-2311
FAX: (435) 653-2436
www.comteco.com

► August 21, 2002

CANYON FUEL CO., SKYLINE MINES
HC 35 P.O. Box 380
Helper, Utah 84526

Sample identification by
Skyline

ID:MC-1

Kind of sample Water
reported to us

RECEIVED 1650
SAMPLED 10.00

FIELD MEASUREMENTS

Sample taken at Skyline

FLOW 12.42 TEMP 13.9

Sample taken by K2

COND 496 pH 8.52

D.O. 6.75 TURBIDITY 3

NOTES:

Date sampled August 15, 2002

Date received August 15, 2002

Page 1 of 1

Analysis report no. 59-24335

Parameter	Result	MRL	Units	Method	Analyzed	
Solids, Total Dissolved	299	10	mg/l	EPA 160.1	08-19-2002	0800 SC
Solids, Total Suspended	27	5	mg/l	EPA 160.2	08-19-2002	0800 SC

FAXED
8/26/02

Respectfully submitted,
COMMERCIAL TESTING & ENGINEERING CO.

Huntington Laboratory

MEMBER
ACIL



COMMERCIAL TESTING & ENGINEERING CO.

GENERAL OFFICES: 1919 SOUTH HIGHLAND AVE., SUITE 210-B, LOMBARD, ILLINOIS 60148 • TEL: 630-953-9300 FAX: 630-953-9306



Member of the SGS Group (Société Générale de Surveillance)

ADDRESS ALL CORRESPONDENCE TO:

P.O. BOX 1020

HUNTINGTON, UT 84528

TEL: (435) 853-2311

FAX: (435) 853-2436

www.comteco.com

► August 21, 2002

CANYON FUEL CO., SKYLINE MINES
HC 35 P.O. Box 380
Helper, Utah 84526

Sample identification by
Skyline

ID:MC-2

Kind of sample Water
reported to us

RECEIVED 1650

SAMPLED 1030

FIELD MEASUREMENTS

Sample taken at Skyline

FLOW 20.95 TEMP 14.0

Sample taken by K2

COND 495 pH 8.50

D.O. 6.88 TURBIDITY 2.6

NOTES:

Date sampled August 15, 2002

Date received August 15, 2002

Page 1 of 1

Analysis report no. 59-24336

Parameter	Result	MRL	Units	Method	Analyzed	
Solids, Total Dissolved	293	10	mg/l	EPA 160.1	08-19-2002	0800 SC
Solids, Total Suspended	24	5	mg/l	EPA 160.2	08-19-2002	0800 SC

FAXED

Respectfully submitted,
COMMERCIAL TESTING & ENGINEERING CO.

Huntington Laboratory

MEMBER
ACIL



COMMERCIAL TESTING & ENGINEERING CO.

GENERAL OFFICES: 1919 SOUTH HIGHLAND AVE., SUITE 210-B, LOMBARD, ILLINOIS 60148 • TEL: 630-953-9300 FAX: 630-953-9306



Member of the SGS Group (Société Générale de Surveillance)

ADDRESS ALL CORRESPONDENCE TO:
P.O. BOX 1020
HUNTINGTON, UT 84528
TEL: (435) 653-2311
FAX: (435) 653-2436
www.comteco.com

► August 21, 2002

CANYON FUEL CO., SKYLINE MINES
HC 35 P.O. Box 380
Helper, Utah 84526

Sample identification by
Skyline

ID:MC-3

Kind of sample Water
reported to us

RECEIVED 1650
SAMPLED 1140

FIELD MEASUREMENTS

Sample taken at Skyline

FLOW 20.17 TEMP 16.1

Sample taken by K2

COND 526 pH 8.49

TURBIDITY 2.1

D.O. 7.35

NOTES:

Date sampled August 15, 2002

Date received August 15, 2002

Page 1 of 1

Analysis report no. 59-24337

Parameter	Result	MRL	Units	Method	Analyzed	Date/Time/Analyst
Solids, Total Dissolved	308	10	mg/l	EPA 160.1	06-19-2002 0800	SC
Solids, Total Suspended	14	5	mg/l	EPA 160.2	06-19-2002 0800	SC

FAXED

F

Respectfully submitted,
COMMERCIAL TESTING & ENGINEERING CO.

Huntington Laboratory

MEMBER
ACIL



COMMERCIAL TESTING & ENGINEERING CO.

GENERAL OFFICES: 1919 SOUTH HIGHLAND AVE., SUITE 210-B, LOMBARD, ILLINOIS 60148 • TEL: 630-953-9300 FAX: 630-953-9306



Member of the SGS Group (Société Générale de Surveillance)

ADDRESS ALL CORRESPONDENCE TO:

P.O. BOX 1020

HUNTINGTON, UT 84528

TEL: (435) 653-2311

FAX: (435) 653-2436

www.comteco.com

► August 21, 2002

CANYON FUEL CO., SKYLINE MINES
HC 35 P.O. Box 380
Helper, Utah 84526

Sample identification by
Skyline

ID: MC-4

Kind of sample Water
reported to us

RECEIVED 1650
SAMPLED 1100

FIELD MEASUREMENTS

Sample taken at Skyline

FLOW 17.01 TEMP 15.9

Sample taken by K2

COND 504 pH 8.50

D.O. 7.13 TURBIDITY 2.7

NOTES:

Date sampled August 15, 2002

Date received August 15, 2002

Page 1 of 1

Analysis report no. 59-24338

Parameter	Result	MRL	Units	Method	Analyzed	Date/Time/Analyst
Solids, Total Dissolved	297	10	mg/l	EPA 160.1	08-19-2002 0800	SC
Solids, Total Suspended	23	5	mg/l	EPA 160.2	08-19-2002 0800	SC

FAXED
BY ACIL

Respectfully submitted,
COMMERCIAL TESTING & ENGINEERING CO.

Huntington Laboratory

MEMBER
ACIL



COMMERCIAL TESTING & ENGINEERING CO.

GENERAL OFFICES: 1919 SOUTH HIGHLAND AVE., SUITE 210-B, LOMBARD, ILLINOIS 60148 • TEL: 630-653-9300 FAX: 630-653-9306



Member of the SGS Group (Société Générale de Surveillance)

ADDRESS ALL CORRESPONDENCE TO:
P.O. BOX 1020
HUNTINGTON, UT 84528
TEL: (435) 653-2311
FAX: (435) 653-2436
www.comteco.com

► August 21, 2002

CANYON FUEL CO., SKYLINE MINES
HC 35 P.O. Box 380
Helper, Utah 84526

Sample identification by
Skyline

ID:MC-5

Kind of sample Water
reported to us

RECEIVED 1650
SAMPLED 0930

FIELD MEASUREMENTS

Sample taken at Skyline

FLOW 1.009 TEMP 9.1

Sample taken by K2

COND 538 pH 8.36

D.O. 7.07 TURBIDITY 3.5

NOTES:

Date sampled August 15, 2002

Date received August 15, 2002

Page 1 of 1

Analysis report no. 59-24339

Parameter	Result	MRL	Units	Method	Analyzed	Date/Time/Analyst
Solids, Total Dissolved	312	10	mg/l	EPA 160.1	08-19-2002 0800	SC
Solids, Total Suspended	12	5	mg/l	EPA 160.2	08-19-2002 0800	SC

FAXED
8-26-02

Respectfully submitted,
COMMERCIAL TESTING & ENGINEERING CO.

Huntington Laboratory

MEMBER
ACIL


Mountain States Analytical, LLC

1645 West 2200 South · Salt Lake City, Utah 84119 · (800) 973-6724

Client: Mr. Chris Hansen
 Canyon Fuel Company, LLC
 Skyline Mines
 HC 35 Box 380
 Helper, UT 84526
 (435) 448-6463

Project: 3rd Quarter

Project ID:

Purchase Order:

Report Number: 0208148-1
Date Reported: 08/26/02
Work Order: 0208148
Lab Sample ID: 0208148-01A
Client Sample ID: MC-1
Date Collected: 08/15/02
Date Received: 08/21/02 08:50
Matrix: Water
COC ID: 25266

Parameter	Result	MDL	PQL	Units	DF	Date Analyzed	Analyst
-----------	--------	-----	-----	-------	----	---------------	---------

EPA 365.3: Phosphorus, Total as P, Water

Phosphorus, total	U	0.02	0.1	mg/L	I	08/22/02	NWL
-------------------	---	------	-----	------	---	----------	-----

U - Not detected above the MDL

B - Analyte detected in the associated Method Blank

S - Results outside normal recovery limits

J - Analyte detected below the PQL

E - Result is outside of quantitation range

R - RPD outside normal precision limits

* - Result is greater than the associated action level


Mountain States Analytical, LLC

1645 West 2200 South - Salt Lake City, Utah 84119 - 800-973-6724

Client: Mr. Chris Hansen
 Canyon Fuel Company, LLC
 Skyline Mines
 HC 35 Box 380
 Helper, UT 84526
 (435) 448-6463

Project: 3rd Quarter

Project ID:

Purchase Order:

Report Number: 0208148-1
Date Reported: 08/26/02
Work Order: 0208148
Lab Sample ID: 0208148-02A
Client Sample ID: MC-2
Date Collected: 08/15/02
Date Received: 08/21/02 08:50
Matrix: Water
COC ID: 25266

Parameter	Result	MDL	PQL	Units	DF	Date Analyzed	Analyst
-----------	--------	-----	-----	-------	----	---------------	---------

EPA 365.3: Phosphorus, Total as P, Water

Phosphorus, total	U	0.02	0.1	mg/L	1	08/22/02	NWL
-------------------	---	------	-----	------	---	----------	-----

U - Not detected above the MDL

J - Analyte detected below the PQL

* - Result is greater than the associated action level

B - Analyte detected in the associated Method Blank

E - Result is outside of quantitation range

S - Results outside normal recovery limits

R - RPD outside normal precision limits


Mountain States Analytical, LLC

1645 West 2200 South • Salt Lake City, Utah 84119 • 800-973-6724

Client: Mr. Chris Hansen
 Canyon Fuel Company, LLC
 Skyline Mincs
 HC 35 Box 380
 Helper, UT 84526
 (435) 448-6463

Project: 3rd Quarter

Project ID:

Purchase Order:

Report Number: 0208148-1
Date Reported: 08/26/02
Work Order: 0208148
Lab Sample ID: 0208148-03A
Client Sample ID: MC-3
Date Collected: 08/15/02
Date Received: 08/21/02 08:50
Matrix: Water
COC ID: 25266

Parameter	Result	MDL	PQL	Units	DF	Date Analyzed	Analyst
-----------	--------	-----	-----	-------	----	---------------	---------

EPA 365.3: Phosphorus, Total as P, Water

Phosphorus, total	U	0.02	0.1	mg/l.	I	08/22/02	NWL
-------------------	---	------	-----	-------	---	----------	-----

U - Not detected above the MDL

B - Analyte detected in the associated Method Blank

S - Results outside normal recovery limits

J - Analyte detected below the PQL

E - Result is outside of quantitation range

R - RPD outside normal precision limits

* - Result is greater than the associated action level


Mountain States Analytical, LLC

1645 West 2200 South • Salt Lake City, Utah 84119 • 800-973-6724

Client: Mr. Chris Hanson Report Number: 0208148-1
 Canyon Fuel Company, LLC Date Reported: 08/26/02
 Skyline Mines Work Order: 0208148
 HC 35 Box 380 Lab Sample ID: 0208148-04A
 Helper, UT 84526 Client Sample ID: MC-4
 (435) 448-6463 Date Collected: 08/15/02
 Project: 3rd Quarter Date Received: 08/21/02 08:50
 Project ID: Matrix: Water
 Purchase Order: COC ID: 25266

Parameter	Result	MDL	PQL	Units	DF	Date Analyzed	Analyst
-----------	--------	-----	-----	-------	----	---------------	---------

EPA 365.3: Phosphorus, Total as P, Water

Phosphorus, total	U	0.02	0.1	mg/L	I	08/22/02	NWL
-------------------	---	------	-----	------	---	----------	-----

U - Not detected above the MDL

B - Analyte detected in the associated Method Blank

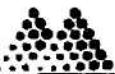
S - Results outside normal recovery limits

J - Analyte detected below the PQL.

E - Result is outside of quantitation range

R - RPD outside normal precision limits

* - Result is greater than the associated action level


Mountain States Analytical, LLC

1645 West 2200 South • Salt Lake City, Utah 84119 • 800-973-6724

Client: Mr. Chris Hansen
 Canyon Fuel Company, LLC
 Skyline Mines
 HC 35 Box 380
 Helper, UT 84526
 (435) 448-6463

Project: 3rd Quarter

Project ID:

Purchase Order:

Report Number: 0208148-1
Date Reported: 08/26/02
Work Order: 0208148
Lab Sample ID: 0208148-05A
Client Sample ID: MC-5
Date Collected: 08/15/02
Date Received: 08/21/02 08:50
Matrix: Water
COC ID: 25266

Parameter	Result	MDL	PQL	Units	DF	Date Analyzed	Analyst
EPA 365.3: Phosphorus, Total as P, Water							
Phosphorus, total	U	0.02	0.1	mg/l.	1	08/22/02	NWL

U - Not detected above the MDL

B - Analyte detected in the associated Method Blank

S - Results outside normal recovery limits

J - Analyte detected below the PQL

E - Result is outside of quantitation range

R - RPD outside normal precision limits

* - Result is greater than the associated action level


Mountain States Analytical, LLC

1645 West 2200 South • Salt Lake City, Utah 84119 • 800-973-6724

Client: Mr. Chris Hansen
 Canyon Fuel Company, LLC
 Skyline Mines
 HC 35 Box 380
 Helper, UT 84526
 (435) 448-6463

Project: 3rd Quarter

Project ID:

Purchase Order:

Report Number: 0208148-1
Date Reported: 08/26/02
Work Order: 0208148
Lab Sample ID: 0208148-06A
Client Sample ID: MD-1
Date Collected: 08/15/02
Date Received: 08/21/02 08:50
Matrix: Water
COC ID: 25266

Parameter	Result	MDL	PQL	Units	DF	Date Analyzed	Analyst
-----------	--------	-----	-----	-------	----	---------------	---------

EPA 365.3: Phosphorus, Total as P, Water

Phosphorus, total	U	0.02	0.1	mg/L	1	08/22/02	NWL.
-------------------	---	------	-----	------	---	----------	------

U - Not detected above the MDL

B - Analyte detected in the associated Method Blank

S - Results outside normal recovery limits

J - Analyte detected below the PQL

E - Result is outside of quantitation range

R - RPD outside normal precision limits

† - Result is greater than the associated action level



COMMERCIAL TESTING & ENGINEERING CO.

GENERAL OFFICES: 1919 SOUTH HIGHLAND AVE., SUITE 210-B, LOMBARD, ILLINOIS 60148 • TEL: 630-953-9300 FAX: 630-953-9306



Member of the SGS Group (Société Générale de Surveillance)

Committed To Excellence

ADDRESS ALL CORRESPONDENCE TO:

P.O. BOX 1020

HUNTINGTON, UT 84528

TEL: (435) 653-2311

FAX: (435) 653-2436

www.comteco.com

October 25, 2002

CANYON FUEL CO., SKYLINE MINES
HC 35 P.O. Box 380
Helper, Utah 84526

Sample identification by
Skyline

ID:MC-1

Kind of sample Water
reported to us

RECEIVED 1650
SAMPLED 1140

FIELD MEASUREMENTS

TEMP 12.8 COND 761
pH 8.63 TURB 9

Sample taken by E. Peterson

NOTES:

Date sampled October 17, 2002

Date received October 17, 2002

Page 1 of 1

Analysis report no. 59-24664

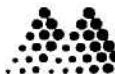
Parameter	Result	MRL	Units	Method	Analyst	Date/Time/Analyst
Solids, Total Dissolved	522	10	mg/l	EPA 160.1	10-23-2002 1015	BLP
Solids, Total Suspended	5	5	mg/l	EPA 160.2	10-23-2002 1015	BLP

FIXED
10-31-02

Respectfully submitted,
COMMERCIAL TESTING & ENGINEERING CO.

Huntington Laboratory

MEMBER
ACIL



Mountain States Analytical, LLC

1645 West 2200 South • Salt Lake City, Utah 84119 • 800-973-6724

Sample Report

Client: Mr. Chris Hansen
Canyon Fuel Company, LLC
Skyline Mines
HC 35 Box 380
Helper, UT 84526
(435) 448-6463

Project: 4th Qtr Sampling

Project ID:

Purchase Order:

Report Number: 0212012-I
Date Reported: 12/10/02
Work Order: 0212012
Lab Sample ID: 0212012-01A
Client Sample ID: MC-1
Date Collected: 11/29/02
Date Received: 12/03/02 09:00
Matrix: Water
COC ID: 26073

Parameter	Result	MDL	PQL	Units	DF	Date Analyzed	Analyst
EPA 365.3: Phosphorus, Total as P, Water							
Phosphorus, total	U	0.02	0.1	mg/L	I	12/04/02 09:50	JKH

U - Not detected above the MDL

B - Analyte detected in the associated Method Blank

S - Results outside normal recovery limits

J - Analyte detected below the PQL

E - Result is outside of quantitation range

R - RPD outside normal precision limits

* - Result is greater than the associated action level

COMMERCIAL TESTING & ENGINEERING CO.

GENERAL OFFICES: 1919 SOUTH HIGHLAND AVE., SUITE 210-B, LOMBARD, ILLINOIS 60148 • TEL: 630-953-9300 FAX: 630-953-9306

SINCE 1908®



Member of the SGS Group (Société Générale de Surveillance)

Committed To Excellence

ADDRESS ALL CORRESPONDENCE TO:

P.O. BOX 1020

HUNTINGTON, UT 84528

TEL: (435) 653-2311

FAX: (435) 653-2436

www.comteco.com

October 25, 2002

CANYON FUEL CO., SKYLINE MINES
HC 35 P.O. Box 380
Helper, Utah 84526Sample identification by
Skyline

ID:MC-2

Kind of sample Water
reported to us

RECEIVED 1650

SAMPLED 1215

FIELD MEASUREMENTS

Sample taken at Skyline Mine

TEMP 13.5 COND 735

Sample taken by E. Peterson

pH 8.64

TURB 8

Date sampled October 17, 2002

NOTES:

Date received October 17, 2002

Page 1 of 1

Analysis report no. 59-24665

Parameter	Result	MRL	Units	Method	Analyst	Date/Time/Analyst
Solids, Total Dissolved	486	10	mg/l	EPA 160.1	10-23-2002 1015	BLP
Solids, Total Suspended	5	5	mg/l	EPA 160.2	10-23-2002 1015	BLP

FILED
*10-3-02*Respectfully submitted,
COMMERCIAL TESTING & ENGINEERING CO.

Huntington Laboratory

MEMBER
ACIL



Mountain States Analytical, LLC

1645 West 2200 South • Salt Lake City, Utah 84119 • 800-973-6724

Client:	Mr. Chris Hansen Canyon Fuel Company, LLC Skyline Mines HC 35 Box 380 Helper, UT 84526 (435) 448-6463	Report Number:	0212012-1
Project:	4th Qtr Sampling	Date Reported:	12/10/02
Project ID:		Work Order:	0212012
Purchase Order:		Lab Sample ID:	0212012-02A
		Client Sample ID:	MC-2
		Date Collected:	11/29/02
		Date Received:	12/03/02 09:00
		Matrix:	Water
		COC ID:	26073

Parameter	Result	MDL	PQL	Units	DF	Date Analyzed	Analyst
-----------	--------	-----	-----	-------	----	---------------	---------

EPA 365.3: Phosphorus, Total as P, Water

Phosphorus, total	U	0.02	0.1	mg/L	I	12/04/02 09:50	JKH
-------------------	---	------	-----	------	---	----------------	-----

U - Not detected above the MDL

B - Analyte detected in the associated Method Blank

S - Results outside normal recovery limits

J - Analyte detected below the PQL

E - Result is outside of quantitation range

R - RPD outside normal precision limits

* - Result is greater than the associated action level



COMMERCIAL TESTING & ENGINEERING CO.

GENERAL OFFICES: 1919 SOUTH HIGHLAND AVE., SUITE 210-B, LOMBARD, ILLINOIS 60148 • TEL: 630-953-9300 FAX: 630-953-9306



Member of the SGS Group (Société Générale de Surveillance)

Committed To Excellence

ADDRESS ALL CORRESPONDENCE TO:

P.O. BOX 1020

HUNTINGTON, UT 84528

TEL: (435) 653-2311

FAX: (435) 653-2436

www.comteco.com

October 25, 2002

CANYON FUEL CO., SKYLINE MINES
HC 35 P.O. Box 380
Helper, Utah 84526

Sample identification by
Skyline

ID:MC-3

Kind of sample Water
reported to us

RECEIVED 1650

SAMPLED 1325

Sample taken at Skyline Mine

FIELD MEASUREMENTS

TEMP 12.5 COND 706

pH 8.86 TURB 8

Sample taken by E. Peterson

NOTES:

Date sampled October 17, 2002

Page 1 of 1

Analysis report no. 59-24666

Parameter	Result	MRL	Units	Method	Analyzed	Date/Time/Analyst
Solids, Total Dissolved	481	10	mg/l	EPA 160.1	10-23-2002 1015	BLP
Solids, Total Suspended	<5	5	mg/l	EPA 160.2	10-23-2002 1015	BLP

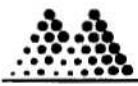
FILED
10-31-02

Respectfully submitted,
COMMERCIAL TESTING & ENGINEERING CO.

Huntington Laboratory

MEMBER
ACIL

OVER 40 BRANCH LABORATORIES STRATEGICALLY LOCATED IN PRINCIPAL COAL MINING AREAS, TIDEWATER AND GREAT LAKES PORTS, AND RIVER LOADING FACILITIES



Mountain States Analytical, LLC

1645 West 2200 South • Salt Lake City, Utah 84119 • 800-973-6724

Client: Mr. Chris Hansen
Canyon Fuel Company, LLC
Skyline Mines
HC 35 Box 380
Helper, UT 84526
(435) 448-6463

Project: 4th Qtr Sampling

Project ID:

Purchase Order:

Report Number: 0212012-1
Date Reported: 12/10/02
Work Order: 0212012
Lab Sample ID: 0212012-03A
Client Sample ID: MC-3
Date Collected: 11/29/02
Date Received: 12/03/02 09:00
Matrix: Water
COC ID: 26073

Parameter	Result	MDL	PQL	Units	DF	Date Analyzed	Analyst
EPA 365.3: Phosphorus, Total as P, Water							
Phosphorus, total	U	0.02	0.1	mg/L	1	12/04/02 09:50	JKH

U - Not detected above the MDL

B - Analyte detected in the associated Method Blank

S -Results outside normal recovery limits

J - Analyte detected below the PQL

E - Result is outside of quantitation range

R - RPD outside normal precision limits

* - Result is greater than the associated action level

COMMERCIAL TESTING & ENGINEERING CO.

GENERAL OFFICES: 1919 SOUTH HIGHLAND AVE., SUITE 210-B, LOMBARD, ILLINOIS 60148 • TEL: 630-953-9300 FAX: 630-953-9306

SINCE 1908®



Member of the SGS Group (Société Générale de Surveillance)

Committed To Excellence

ADDRESS ALL CORRESPONDENCE TO:

P.O. BOX 1020

HUNTINGTON, UT 84528

TEL: (435) 653-2311

FAX: (435) 653-2436

www.comteco.com

October 25, 2002

CANYON FUEL CO., SKYLINE MINES
HC 35 P.O. Box 380
Helper, Utah 84526

Sample identification by
Skyline

ID:MC-4

Kind of sample Water
reported to us

RECEIVED 1650

SAMPLED 1255

FIELD MEASUREMENTS

Sample taken at Skyline Mine

TEMP 15.2

COND 681

pH 8.95

TURB 6

Sample taken by E. Peterson

NOTES:

Date sampled October 17, 2002

Page 1 of 1

Analysis report no. 59-24667

Analyzed

Parameter	Result	MRL	Units	Method	Date/Time/Analyst
Solids, Total Dissolved	489	10	mg/l	EPA 160.1	10-23-2002 1015 BLP
Solids, Total Suspended	5	5	mg/l	EPA 160.2	10-23-2002 1015 BLP

FAXED
10-27-02

Respectfully submitted,
COMMERCIAL TESTING & ENGINEERING CO.

Huntington Laboratory

MEMBER
ACIL

OVER 40 BRANCH LABORATORIES STRATEGICALLY LOCATED IN PRINCIPAL COAL MINING AREAS, TIDEWATER AND GREAT LAKES PORTS, AND RIVER LOADING FACILITIES

Mountain States Analytical, LLC

1645 West 2200 South • Salt Lake City, Utah 84119 • 800-973-6724

Client: Mr. Chris Hansen Report Number: 0212012-1
Canyon Fuel Company, LLC Date Reported: 12/10/02
Skyline Mines Work Order: 0212012
HC 35 Box 380 Lab Sample ID: 0212012-04A
Helper, UT 84526 Client Sample ID: MC-4
(435) 448-6463 Date Collected: 11/29/02
Project: 4th Qtr Sampling Date Received: 12/03/02 09:00
Project ID: Matrix: Water
Purchase Order: COC ID: 26073

Parameter	Result	MDL	PQL	Units	DF	Date Analyzed	Analyst
EPA 365.3: Phosphorus, Total as P, Water							
Phosphorus, total	U	0.02	0.1	mg/L	I	12/04/02 09:50	JKH

U - Not detected above the MDL

B - Analyte detected in the associated Method Blank

S - Results outside normal recovery limits

J - Analyte detected below the PQL

E - Result is outside of quantitation range

R - RPD outside normal precision limits

* - Result is greater than the associated action level

COMMERCIAL TESTING & ENGINEERING CO.

GENERAL OFFICES: 1919 SOUTH HIGHLAND AVE., SUITE 210-B, LOMBARD, ILLINOIS 60148 • TEL: 630-953-9300 FAX: 630-953-9306

SINCE 1908®



Member of the SGS Group (Société Générale de Surveillance)

Committed To Excellence

ADDRESS ALL CORRESPONDENCE TO:

P.O. BOX 1020

HUNTINGTON, UT 84528

TEL: (435) 653-2311

FAX: (435) 653-2436

www.comteco.com

October 25, 2002

CANYON FUEL CO., SKYLINE MINES
HC 35 P.O. Box 380
Helper, Utah 84526

Sample identification by
Skyline

ID:MC-5

Kind of sample Water
reported to us

RECEIVED 1650

SAMPLED 1425

FIELD MEASUREMENTS

Sample taken at Skyline Mine

TEMP 10.8 COND 575

Sample taken by E. Peterson

pH 8.23

TURB 44

Date sampled October 17, 2002

NOTES:

Date received October 17, 2002

Page 1 of 1

Analysis report no. 59-24668

Analyzed

Parameter	Result	MRL	Units	Method	Date/Time/Analyst
Solids, Total Dissolved	367	10	mg/l	EPA 160.1	10-23-2002 1015 BLP
Solids, Total Suspended	60	5	mg/l	EPA 160.2	10-23-2002 1015 BLP

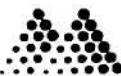
FAXED
10-31-02

Respectfully submitted,
COMMERCIAL TESTING & ENGINEERING CO.

Huntington Laboratory

MEMBER
ACIL

OVER 40 BRANCH LABORATORIES STRATEGICALLY LOCATED IN PRINCIPAL COAL MINING AREAS, TIDEWATER AND GREAT LAKES PORTS, AND RIVER LOADING FACILITIES



Mountain States Analytical, LLC

1645 West 2200 South · Salt Lake City, Utah 84119 · 800-973-6724

Client:	Mr. Chris Hansen Canyon Fuel Company, LLC Skyline Mines HC 35 Box 380 Helper, UT 84526 (435) 448-6463	Report Number:	0212012-I
		Date Reported:	12/10/02
		Work Order:	0212012
		Lab Sample ID:	0212012-05A
		Client Sample ID:	MC-5
		Date Collected:	11/29/02
Project:	4th Qtr Sampling	Date Received:	12/03/02 09:00
Project ID:		Matrix:	Water
Purchase Order:		COC ID:	26073

Parameter	Result	MDL	PQL	Units	DF	Date Analyzed	Analyst
-----------	--------	-----	-----	-------	----	---------------	---------

EPA 365.3: Phosphorus, Total as P, Water

Phosphorus, total	0.034 J	0.02	0.1	mg/L	1	12/04/02 09:50	JKH
-------------------	---------	------	-----	------	---	----------------	-----

U - Not detected above the MDL

B - Analyte detected in the associated Method Blank

S - Results outside normal recovery limits

J - Analyte detected below the PQL

E - Result is outside of quantitation range

R - RPD outside normal precision limits

* - Result is greater than the associated action level

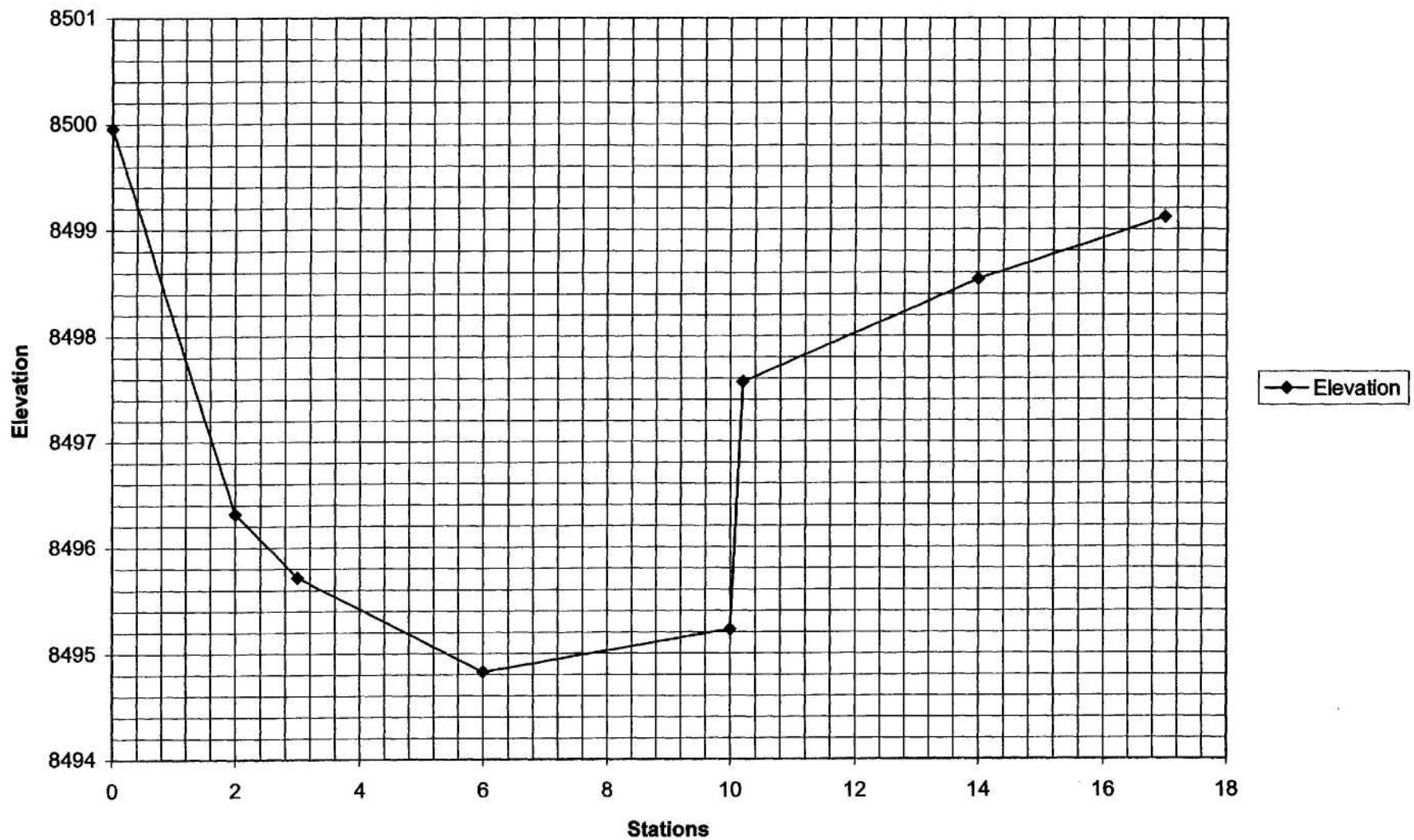
Canyon Fuel Company
Skyline Mine

Mine-Water Discharge Impact
December 2002

APPENDIX E

Channel Cross-Section and Profile Plots

Cross-Section EC-1

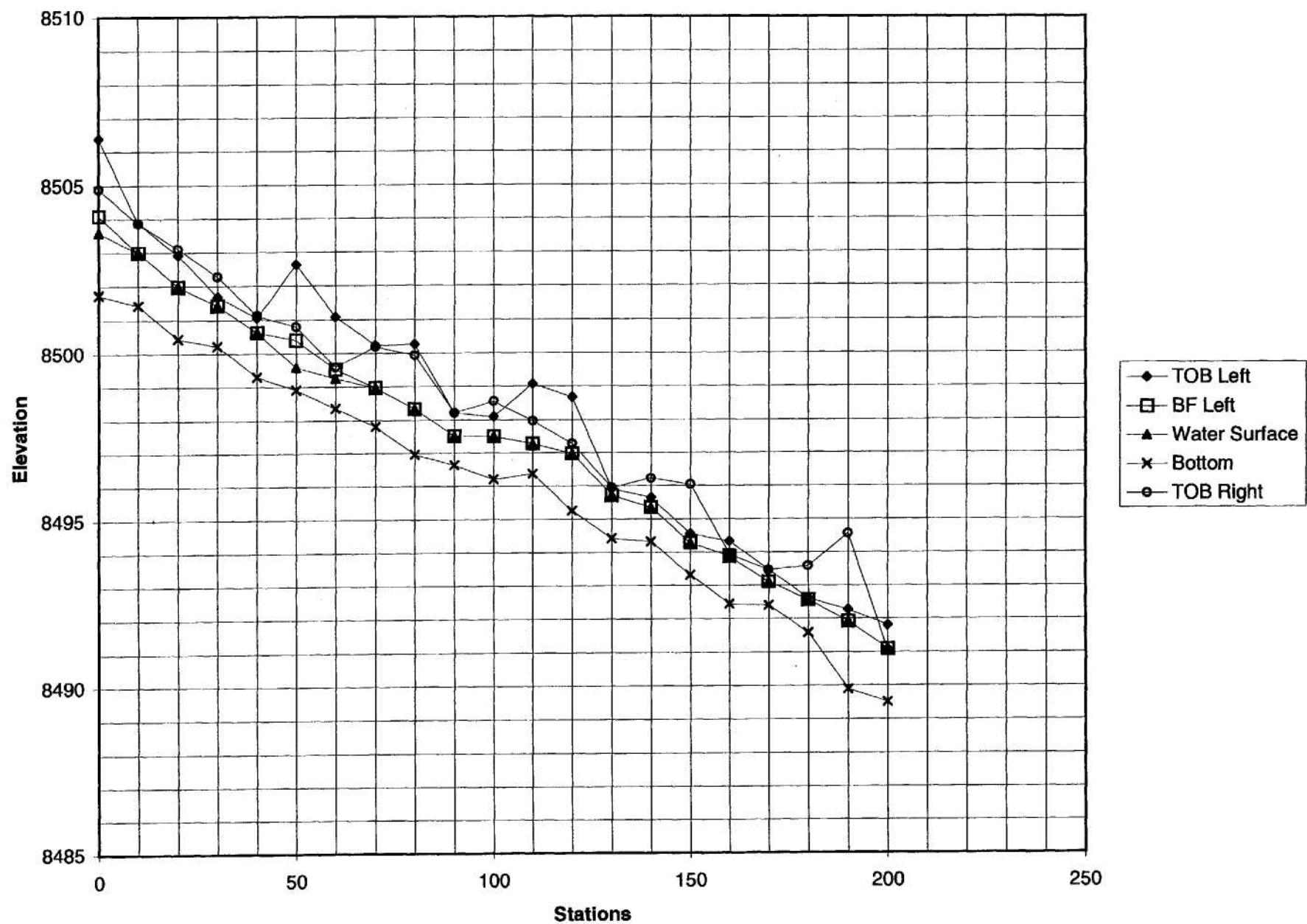


Cross Section: EC-1 Elev: 8499.127

BenchMark1: 7.43

Station	Rod Reading	Elevation	El Change Ft	Distance Ft	Slope Degrees
0	6.6	8499.957			
2	10.24	8496.317	3.64	2	61
3	10.84	8495.717	0.6	1	31
6	11.73	8494.827	0.89	3	17
10	11.33	8495.227	-0.4	4	-6
10.2	8.99	8497.567	-2.34	0.2	-85
14	8.02	8498.537	-0.97	3.8	-14
17	7.44	8499.117	-0.58	3	-11

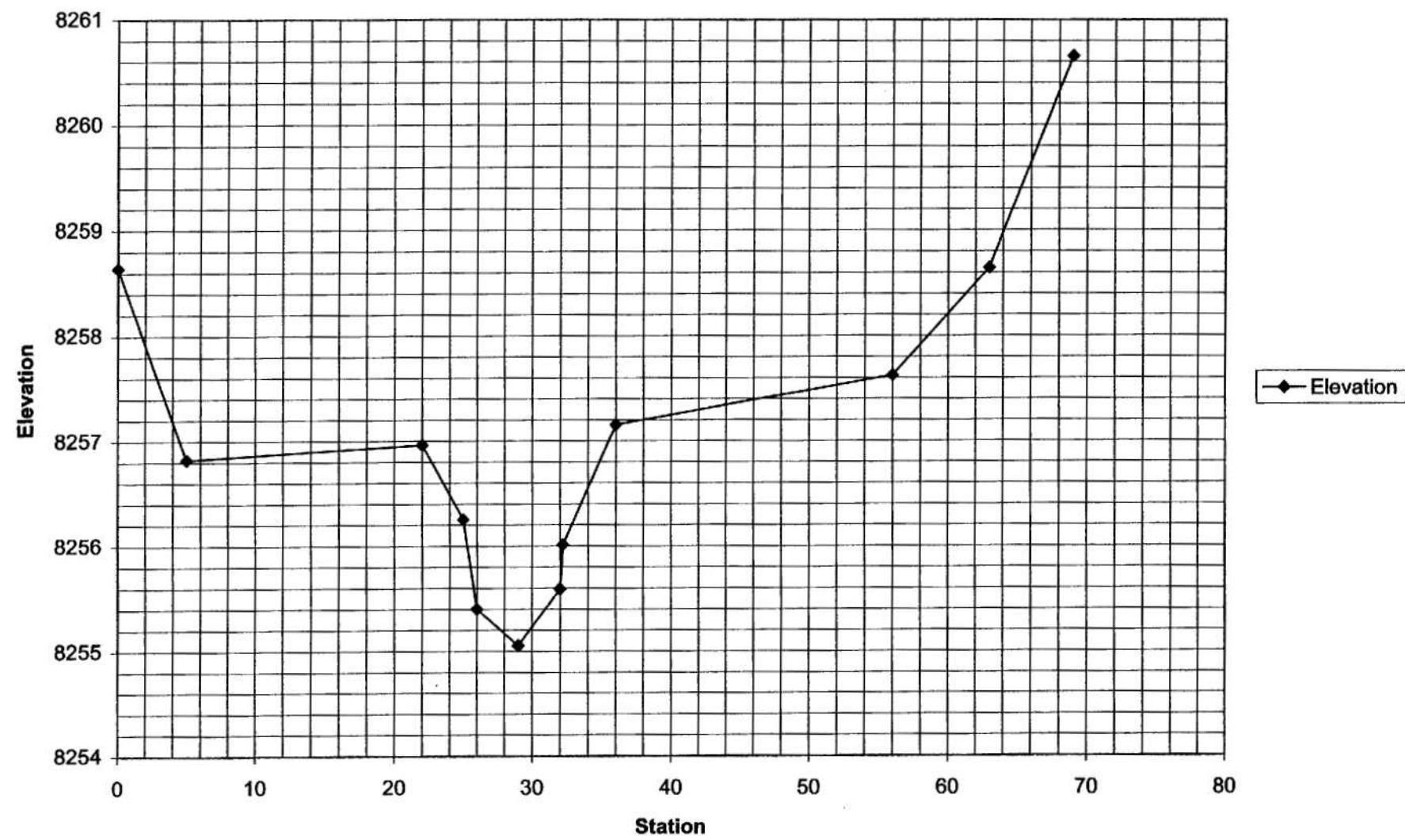
Profile EC-1



Profile:	EC-1	BenchMark Elev:		8499.127							
	BenchMark1:		7.32	BenchMark2:	1.55						
Station	TOB Left		BF Left		Water Surface		Bottom		TOB Right		
	Rod Reading	Elevation	Rod Reading	Elevation	Rod Reading	Elevation	Rod Reading	Elevation	Rod Reading	Elevation	
0	0.05	8506.397	2.35	8504.097	2.85	8503.597	4.7	8501.747	1.55	8504.897	
10	2.57	8503.877	3.45	8502.997	3.45	8502.997	5.01	8501.437	2.58	8503.867	
20	3.53	8502.917	4.47	8501.977	4.47	8501.977	6.01	8500.437	3.34	8503.107	
30	4.76	8501.687	5.02	8501.427	5.02	8501.427	6.22	8500.227	4.17	8502.277	
40	5.38	8501.067	5.82	8500.627	5.82	8500.627	7.15	8499.297	5.32	8501.127	
50	3.82	8502.627	6.05	8500.397	6.87	8499.577	7.54	8498.907	5.65	8500.797	
60	5.36	8501.087	6.93	8499.517	7.2	8499.247	8.09	8498.357	6.86	8499.587	
70	6.21	8500.237	7.48	8498.967	7.48	8498.967	8.64	8497.807	6.25	8500.197	
80	6.18	8500.267	8.11	8498.337	8.11	8498.337	9.49	8496.957	6.51	8499.937	
New Bench Mark											
90	2.47	8498.207	3.16	8497.517	3.16	8497.517	4.04	8496.637	2.46	8498.217	
100	2.58	8498.097	3.17	8497.507	3.17	8497.507	4.48	8496.197	2.12	8498.557	
110	1.61	8499.067	3.4	8497.277	3.4	8497.277	4.31	8496.367	2.71	8497.967	
120	2	8498.677	3.7	8496.977	3.7	8496.977	5.42	8495.257	3.4	8497.277	
130	4.77	8495.907	4.96	8495.717	4.96	8495.717	6.26	8494.417	4.73	8495.947	
140	5.03	8495.647	5.32	8495.357	5.32	8495.357	6.35	8494.327	4.45	8496.227	
150	6.12	8494.557	6.4	8494.277	6.4	8494.277	7.35	8493.327	4.64	8496.037	
160	6.35	8494.327	6.79	8493.887	6.79	8493.887	8.23	8492.447	6.73	8493.947	
170	7.19	8493.487	7.56	8493.117	7.56	8493.117	8.27	8492.407	7.2	8493.477	
180	8.06	8492.617	8.11	8492.567	8.11	8492.567	9.1	8491.577	7.08	8493.597	
190	8.41	8492.267	8.76	8491.917	8.76	8491.917	10.78	8489.897	6.12	8494.557	
200	8.88	8491.797	9.58	8491.097	9.58	8491.097	11.17	8489.507	9.64	8491.037	

Max. Slope: 9.5 degrees
 Min. Slope: -1.0 degrees
 Ave Slope: 3.5 degrees

Cross-section EC-2

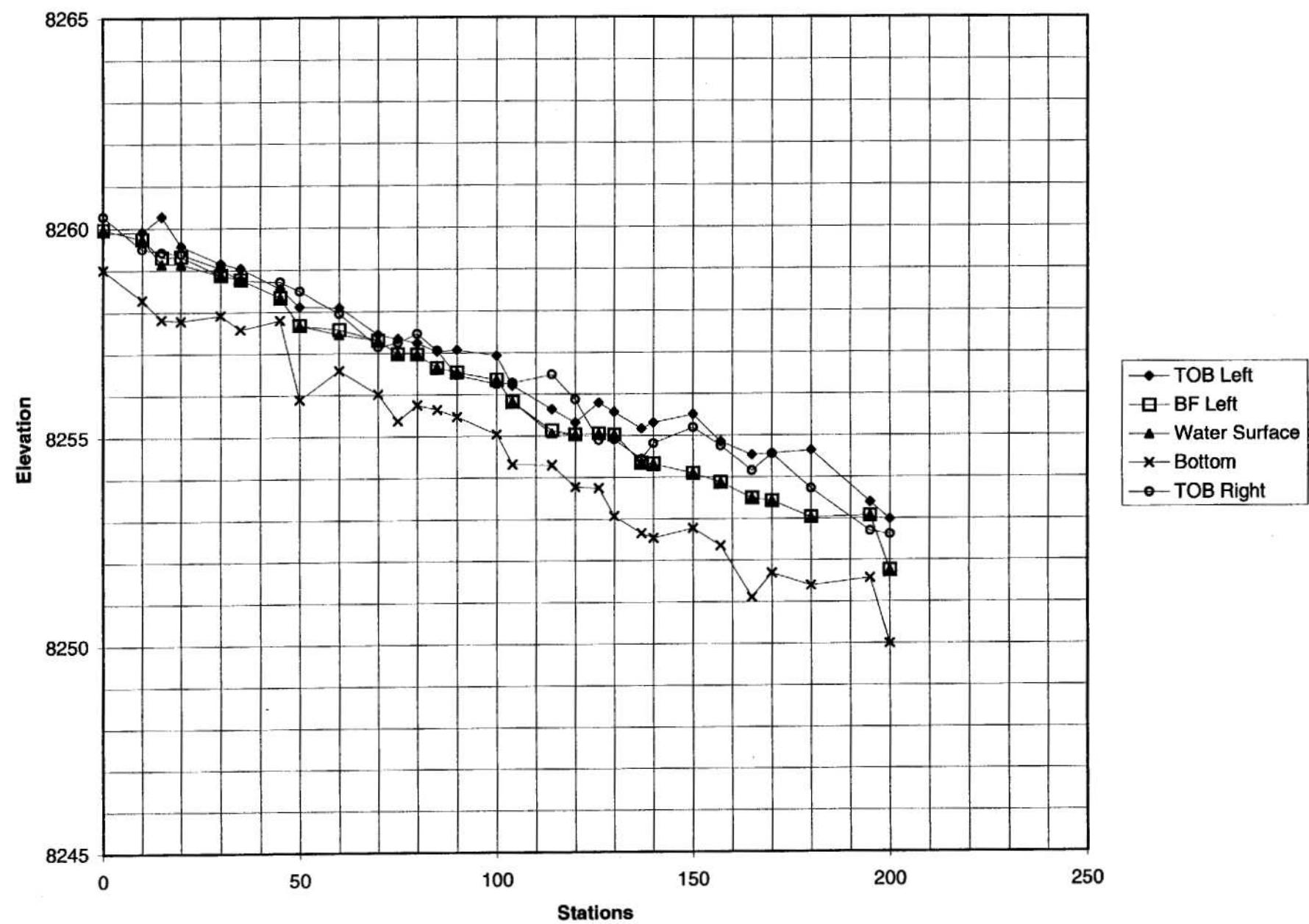


Cross Section: EC-2 Elev: 8257.723

BenchMark1: 5.53

Station	Rod Reading	Elevation	El Change Ft	Distance Ft	Slope Degrees
0	4.61	8258.643			
5	6.43	8256.823	1.82	5	20
22	6.29	8256.963	-0.14	17	0
25	7	8256.253	0.71	3	13
26	7.85	8255.403	0.85	1	40
29	8.2	8255.053	0.35	3	7
32	7.66	8255.593	-0.54	3	-10
32.2	7.24	8256.013	-0.42	0.2	-65
36	6.1	8257.153	-1.14	3.8	-17
56	5.63	8257.623	-0.47	20	-1
63	4.61	8258.643	-1.02	7	-8
69	2.6	8260.653	-2.01	6	-19

Profile EC-2

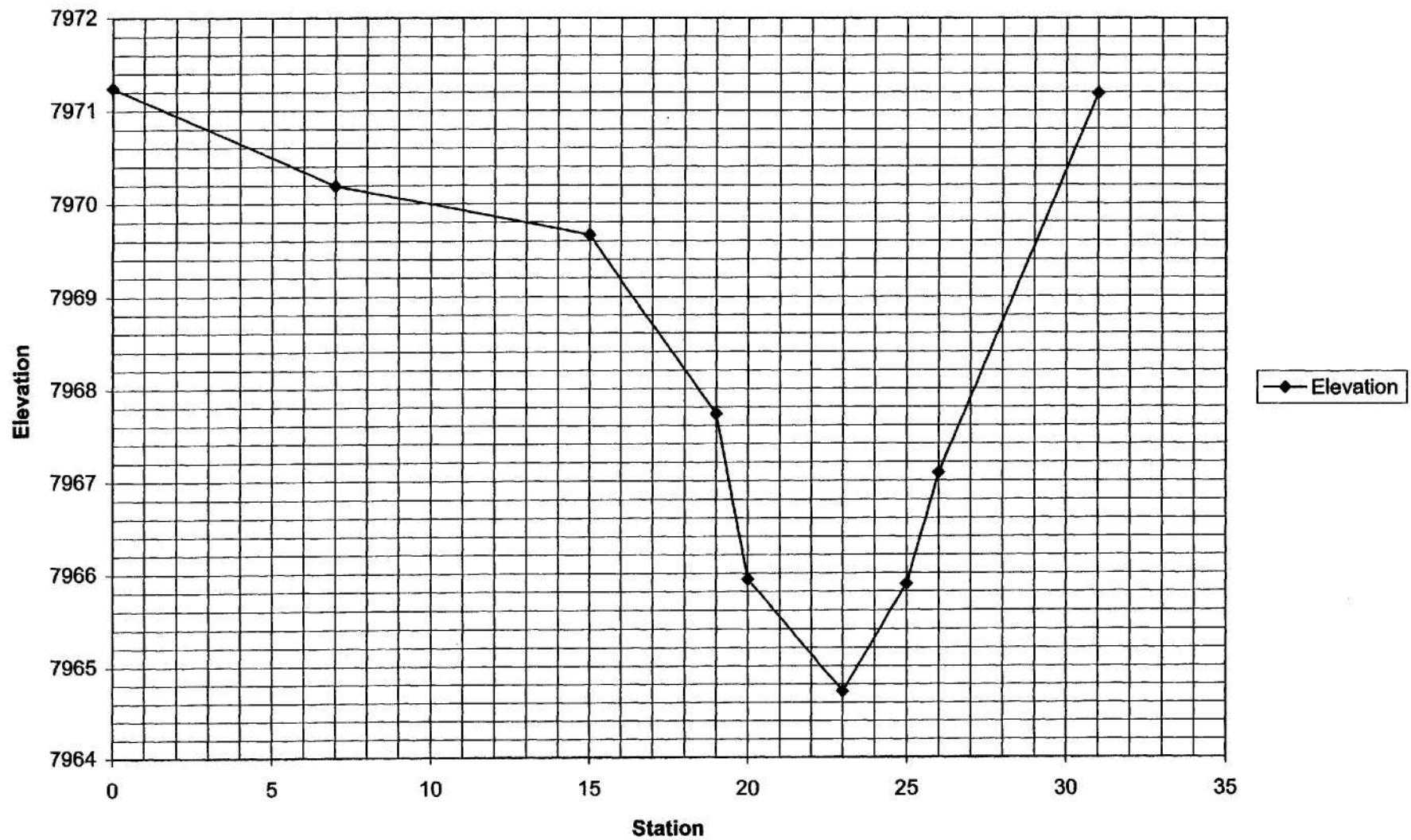


Profile: EC-2 BenchMark Elev:
BenchMark1: 5.53

Station	TOB Left		BF Left		Water Surface		Bottom		TOB Right		Elevation
	Rod Reading	Elevation	Rod Reading	Elevation	Rod Reading	Elevation	Rod Reading	Elevation	Rod Reading	Elevation	
0	3.37	8259.883	3.28	8259.973	3.28	8259.973	4.25	8259.003	2.97	8260.283	
10	3.34	8259.913	3.51	8259.743	3.51	8259.743	4.96	8258.293	3.75	8259.503	
15	2.98	8260.273	3.95	8259.303	4.11	8259.143	5.43	8257.823	3.83	8259.423	
20	3.68	8259.573	3.93	8259.323	4.11	8259.143	5.46	8257.793	3.87	8259.383	
30	4.1	8259.153	4.38	8258.873	4.38	8258.873	5.33	8257.923	4.22	8259.033	
35	4.22	8259.033	4.48	8258.773	4.48	8258.773	5.67	8257.583	4.5	8258.753	
45	4.7	8258.553	4.91	8258.343	4.91	8258.343	5.45	8257.803	4.54	8258.713	
50	5.13	8258.123	5.58	8257.673	5.58	8257.673	7.36	8255.893	4.76	8258.493	
60	5.15	8258.103	5.68	8257.573	5.8	8257.453	6.67	8256.583	5.3	8257.953	
70	5.8	8257.453	5.94	8257.313	5.94	8257.313	7.24	8256.013	6.1	8257.153	
75	5.91	8257.343	6.27	8256.983	6.27	8256.983	7.88	8255.373	6	8257.253	
80	6.01	8257.243	6.28	8256.973	6.28	8256.973	7.5	8255.753	5.79	8257.463	
85	6.21	8257.043	6.61	8256.643	6.61	8256.643	7.61	8255.643	6.19	8257.063	
90	6.18	8257.073	6.72	8256.533	6.72	8256.533	7.78	8255.473	6.79	8256.463	
100	6.32	8256.933	6.9	8256.353	6.9	8256.353	8.21	8255.043	7.01	8256.243	
104	7.04	8256.213	7.43	8255.823	7.43	8255.823	8.94	8254.313	6.98	8256.273	
114	7.61	8255.643	8.12	8255.133	8.2	8255.053	8.96	8254.293	6.78	8256.473	
120	7.93	8255.323	8.22	8255.033	8.22	8255.033	9.48	8253.773	7.38	8255.873	
126	7.46	8255.793	8.2	8255.053	8.2	8255.053	9.51	8253.743	8.37	8254.883	
130	7.68	8255.573	8.23	8255.023	8.23	8255.023	10.18	8253.073	8.35	8254.903	
137	8.08	8255.173	8.91	8254.343	8.91	8254.343	10.6	8252.653	8.82	8254.433	
140	7.94	8255.313	8.94	8254.313	8.94	8254.313	10.71	8252.543	8.45	8254.803	
150	7.74	8255.513	9.16	8254.093	9.16	8254.093	10.48	8252.773	8.06	8255.193	
157	8.41	8254.843	9.38	8253.873	9.38	8253.873	10.9	8252.353	8.51	8254.743	
165	8.73	8254.523	9.75	8253.503	9.75	8253.503	12.14	8251.113	9.1	8254.153	
170	8.69	8254.563	9.82	8253.433	9.82	8253.433	11.56	8251.693	8.71	8254.543	
180	8.62	8254.633	10.22	8253.033	10.22	8253.033	11.86	8251.393	9.53	8253.723	
195	9.86	8253.393	10.18	8253.073	10.18	8253.073	11.68	8251.573	10.56	8252.693	
200	10.27	8252.983	11.5	8251.753	11.5	8251.753	13.25	8250.003	10.64	8252.613	

Max. Slope: 17.4 degrees
Min. Slope: -6.6 degrees
Ave Slope: 2.9 degrees

Cross-section EC-3

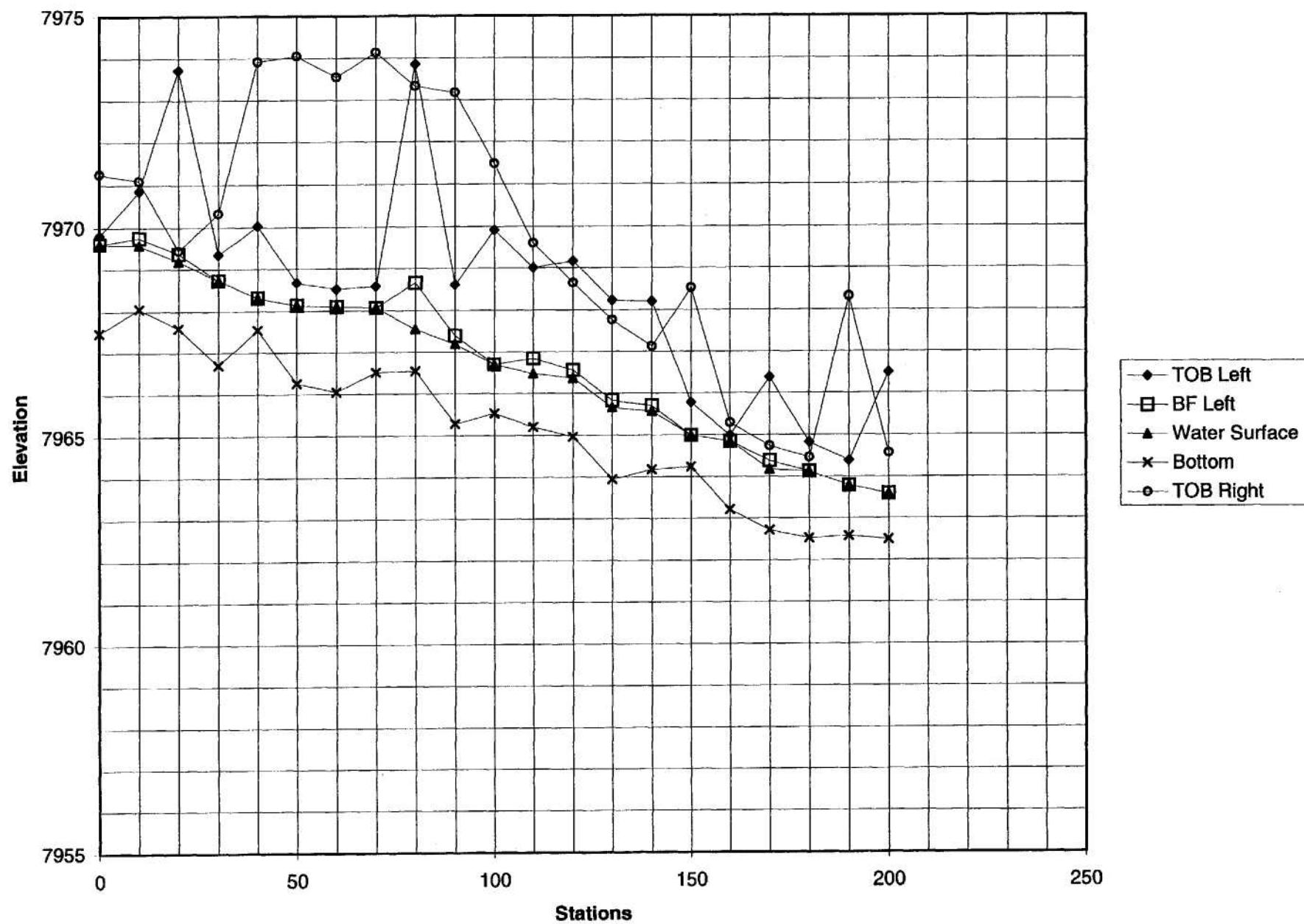


Cross Section: EC-3 Elev: 7971.594

BenchMark1: 1.99

Station	Rod Reading	Elevation	El Change Ft	Distance Ft	Slope Degrees
0	2.34	7971.244			
7	3.39	7970.194	1.05	7	9
15	3.92	7969.664	0.53	8	4
19	5.86	7967.724	1.94	4	26
20	7.65	7965.934	1.79	1	61
23	8.86	7964.724	1.21	3	22
25	7.7	7965.884	-1.16	2	-30
26	6.5	7967.084	-1.2	1	-50
31	2.4	7971.184	-4.1	5	-39

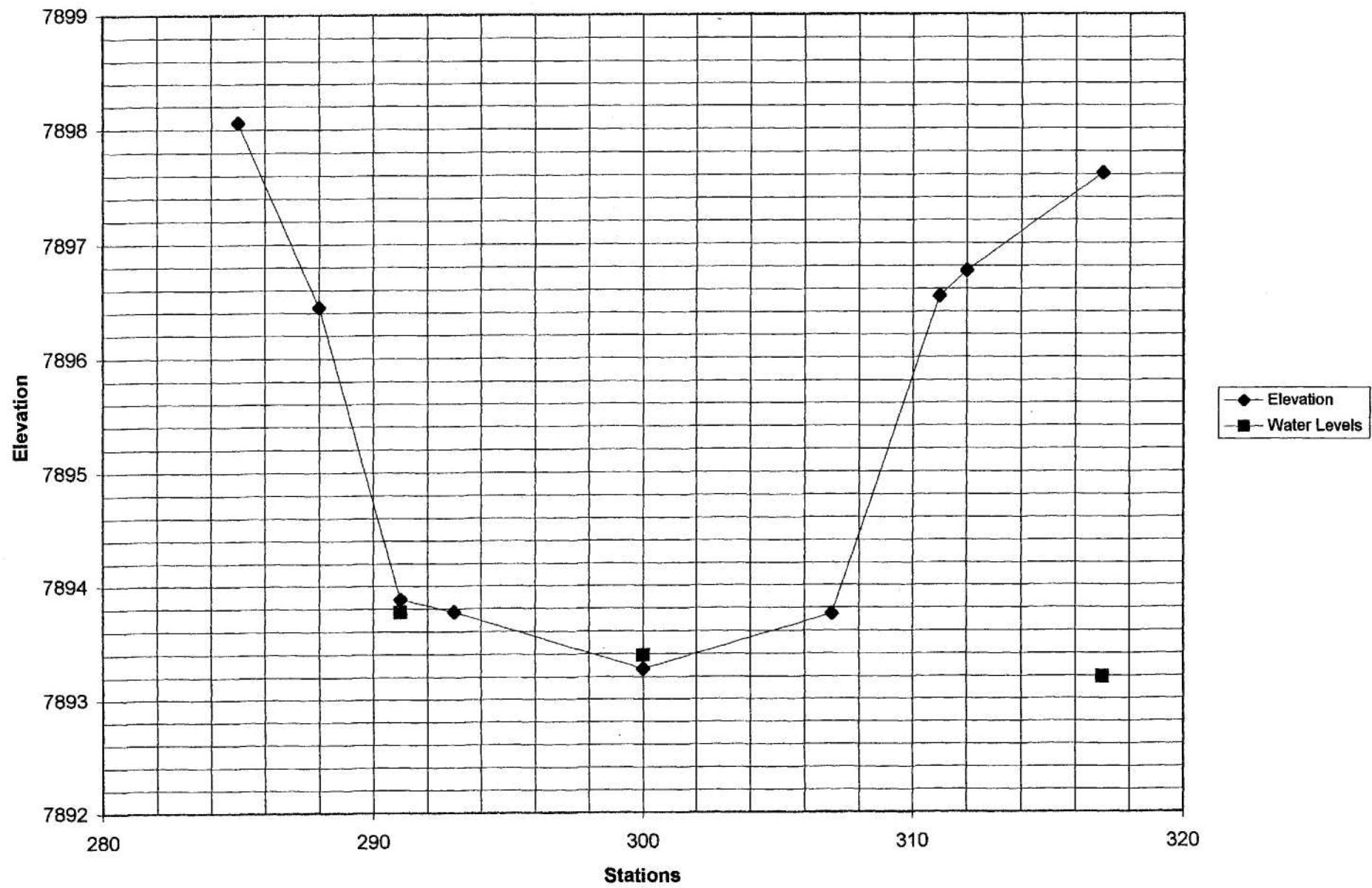
Profile EC-3



Profile:	EC-3	BenchMark Elev:	7971.594									
	BenchMark1:	4.96	BenchMark2:	1.99								
Station	TOB Left		BF Left		Water Surface		Bottom		TOB Right			
	Rod Reading	Elevation	Rod Reading	Elevation	Rod Reading	Elevation	Rod Reading	Elevation	Rod Reading	Elevation	Rod Reading	Elevation
0	6.75	7969.804	6.95	7969.604	6.95	7969.604	9.08	7967.474	5.3	7971.254		
10	5.7	7970.854	6.8	7969.754	6.98	7969.574	8.49	7968.064	5.46	7971.094		
20	2.83	7973.724	7.18	7969.374	7.37	7969.184	8.96	7967.594	7.11	7969.444		
30	7.21	7969.344	7.83	7968.724	7.83	7968.724	9.86	7966.694	6.23	7970.324		
40	6.53	7970.024	8.24	7968.314	8.24	7968.314	9.01	7967.544	2.63	7973.924		
50	7.89	7968.664	8.41	7968.144	8.41	7968.144	10.29	7966.264	2.5	7974.054		
60	8.04	7968.514	8.45	7968.104	8.45	7968.104	10.5	7966.054	3	7973.554		
70	7.98	7968.574	8.48	7968.074	8.48	7968.074	10.04	7966.514	2.42	7974.134		
80	2.7	7973.854	7.9	7968.654	9	7967.554	10.01	7966.544	3.22	7973.334		
90	7.95	7968.604	9.16	7967.394	9.36	7967.194	11.27	7965.284	3.38	7973.174		
100	6.64	7969.914	9.86	7966.694	9.86	7966.694	11.02	7965.534	5.07	7971.484		
110	7.55	7969.004	9.71	7966.844	10.08	7966.474	11.35	7965.204	6.95	7969.604		
120	7.39	7969.164	10	7966.554	10.19	7966.364	11.59	7964.964	7.91	7968.644		
130	8.33	7968.224	10.72	7965.834	10.89	7965.664	12.61	7963.944	8.79	7967.764		
140	8.35	7968.204	10.85	7965.704	10.98	7965.574	12.38	7964.174	9.43	7967.124		
New Bench Mark												
150	7.8	7965.784	8.59	7964.994	8.59	7964.994	9.35	7964.234	5.06	7968.524		
160	8.59	7964.994	8.74	7964.844	8.74	7964.844	10.37	7963.214	8.29	7965.294		
170	7.21	7966.374	9.21	7964.374	9.41	7964.174	10.87	7962.714	8.85	7964.734		
180	8.77	7964.814	9.46	7964.124	9.46	7964.124	11.06	7962.524	9.13	7964.454		
190	9.21	7964.374	9.8	7963.784	9.8	7963.784	11.01	7962.574	5.27	7968.314		
200	7.09	7966.494	9.99	7963.594	9.99	7963.594	11.09	7962.494	9.02	7964.564		

Max. Slope: 7.3 degrees
 Min. Slope: -4.9 degrees
 Ave Slope: 1.4 degrees

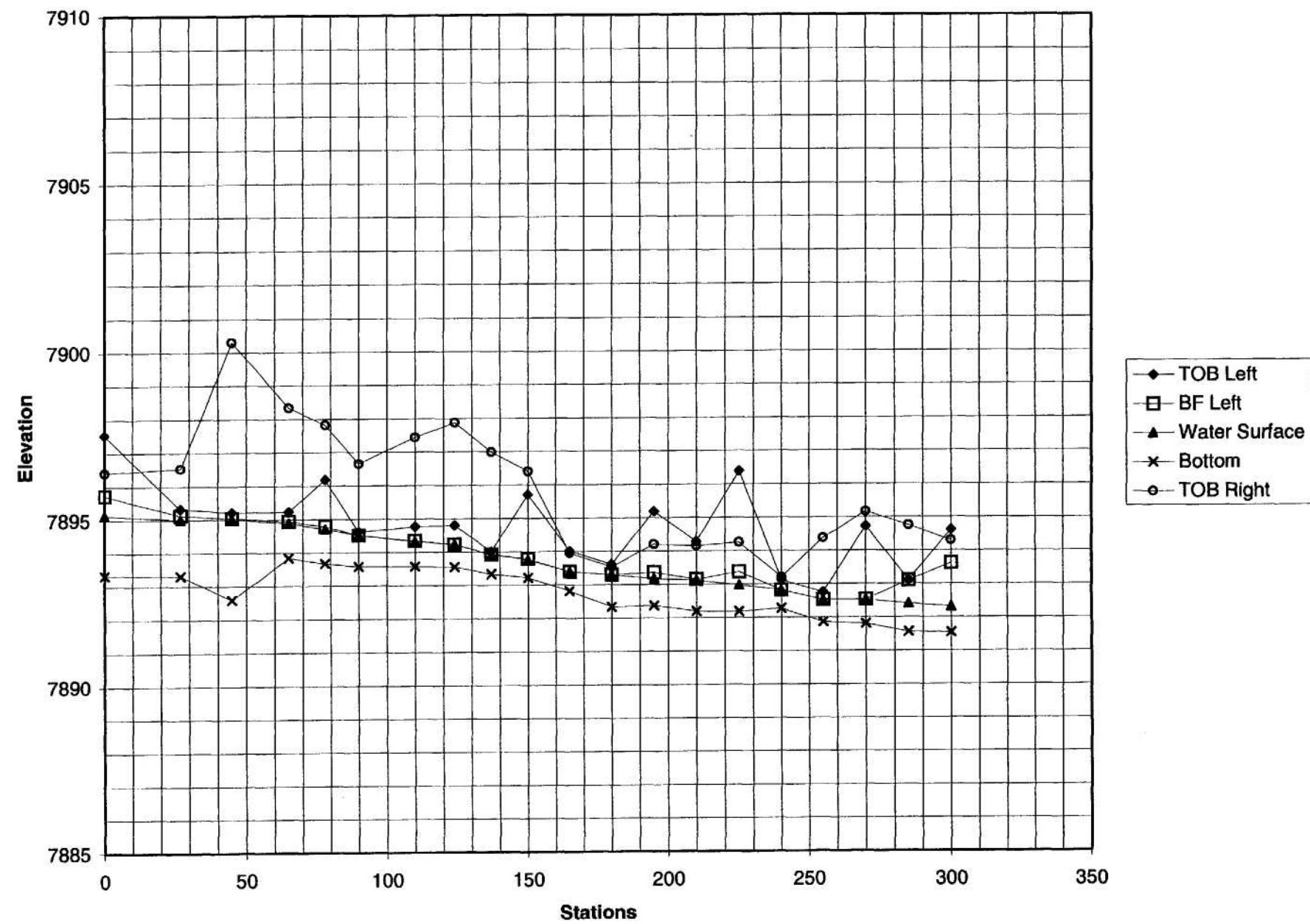
Cross-Section MC-1



Cross Section: MC-1 Elev: 7898.53
BenchMark1: 0.74

Station	Adj. Station	Rod Reading	Elevation	Water Levels	Well I.D.s	El Change Ft	Distance Ft	Slope Degrees
0	285	1.21	7898.06					
3	288	2.82	7896.45			1.61	3	28
6	291	5.39	7893.88	7893.77	1a	2.57	3	41
8	293	5.5	7893.77			0.11	2	3
15	300	6	7893.27	7893.39		0.5	7	4
22	307	5.52	7893.75			-0.48	7	-4
26	311	2.73	7896.54			-2.79	4	-35
27	312	2.51	7896.76			-0.22	1	-12
32	317	1.66	7897.61	7893.19	1b	-0.85	5	-10

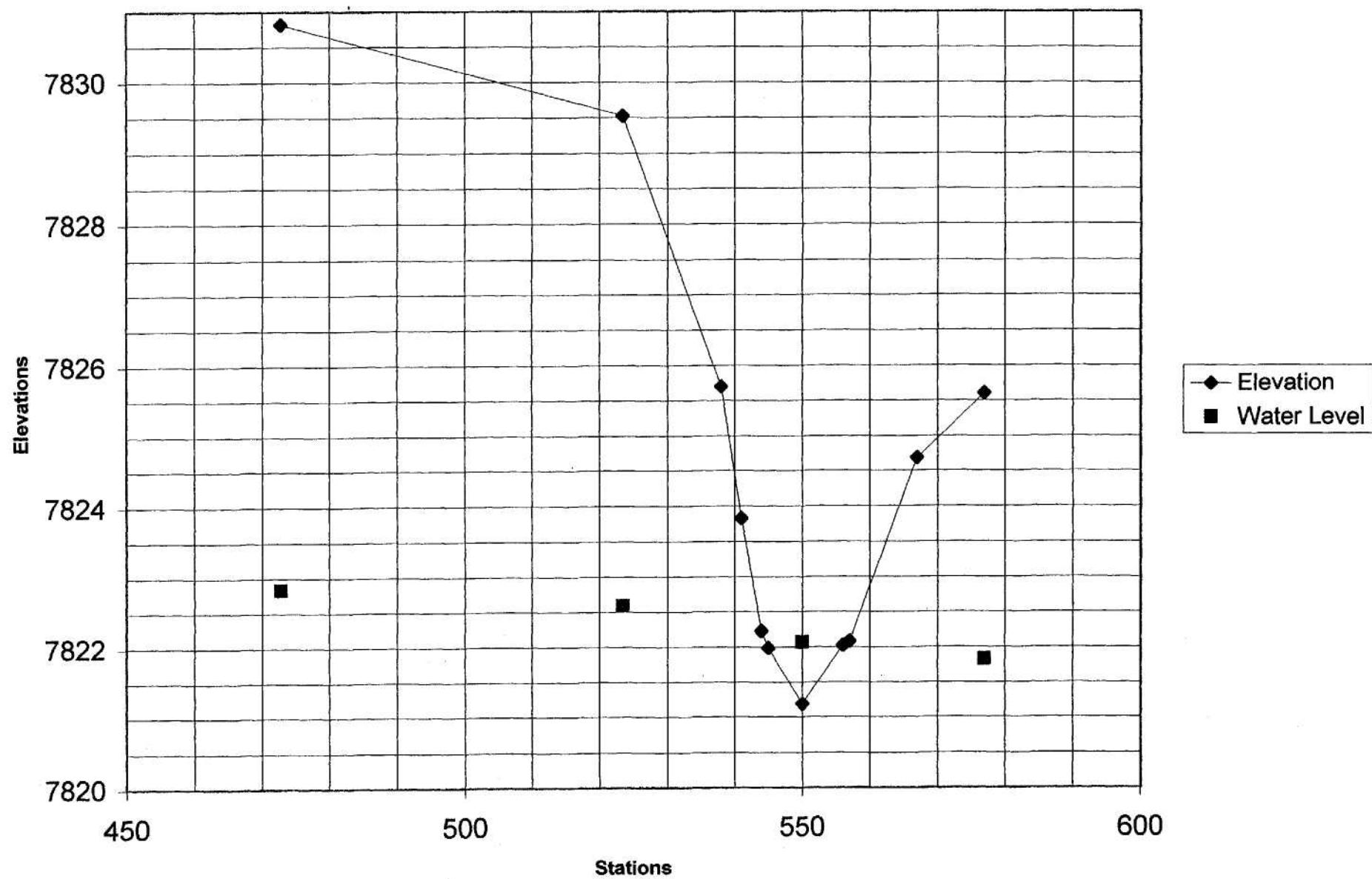
Profile MC-1



Profile:	MC-1	BenchMark Elev:		7898.53								
	BenchMark:		0.74									
Station	TOB Left		BF Left		Water Surface		Bottom		TOB Right			
	Rod Reading	Elevation	Rod Reading	Elevation	Rod Reading	Elevation	Rod Reading	Elevation	Rod Reading	Elevation		
0	1.73	7897.54	3.53	7895.74	4.13	7895.14	5.93	7893.34	2.85	7896.42		
27	3.94	7895.33	4.14	7895.13	4.26	7895.01	5.95	7893.32	2.73	7896.54		
45	4.05	7895.22	4.22	7895.05	4.26	7895.01	6.68	7892.59	-1.04	7900.31		
65	4.04	7895.23	4.33	7894.94	4.38	7894.89	5.43	7893.84	0.93	7898.34		
78	3.08	7896.19	4.48	7894.79	4.56	7894.71	5.6	7893.67	1.45	7897.82		
90	4.65	7894.62	4.75	7894.52	4.75	7894.52	5.7	7893.57	2.61	7896.66		
110	4.5	7894.77	4.93	7894.34	4.95	7894.32	5.7	7893.57	1.83	7897.44		
124	4.47	7894.8	5.04	7894.23	5.04	7894.23	5.72	7893.55	1.39	7897.88		
137	5.26	7894.01	5.35	7893.92	5.36	7893.91	5.94	7893.33	2.28	7896.99		
150	3.56	7895.71	5.49	7893.78	5.51	7893.76	6.05	7893.22	2.86	7896.41		
165	5.26	7894.01	5.88	7893.39	5.88	7893.39	6.46	7892.81	5.32	7893.95		
180	5.66	7893.61	5.97	7893.3	5.97	7893.3	6.94	7892.33	5.74	7893.53		
195	4.08	7895.19	5.91	7893.36	6.09	7893.18	6.9	7892.37	5.07	7894.2		
210	4.99	7894.28	6.12	7893.15	6.15	7893.12	7.08	7892.19	5.12	7894.15		
225	2.88	7896.39	5.9	7893.37	6.3	7892.97	7.09	7892.18	5.02	7894.25		
240	6.15	7893.12	6.45	7892.82	6.45	7892.82	7	7892.27	6.07	7893.2		
255	6.52	7892.75	6.75	7892.52	6.75	7892.52	7.41	7891.86	4.9	7894.37		
270	4.55	7894.72	6.75	7892.52	6.75	7892.52	7.47	7891.8	4.1	7895.17		
285	6.17	7893.1	6.17	7893.1	6.87	7892.4	7.71	7891.56	4.52	7894.75		
300	4.66	7894.61	5.66	7893.61	6.96	7892.31	7.73	7891.54	4.98	7894.29		

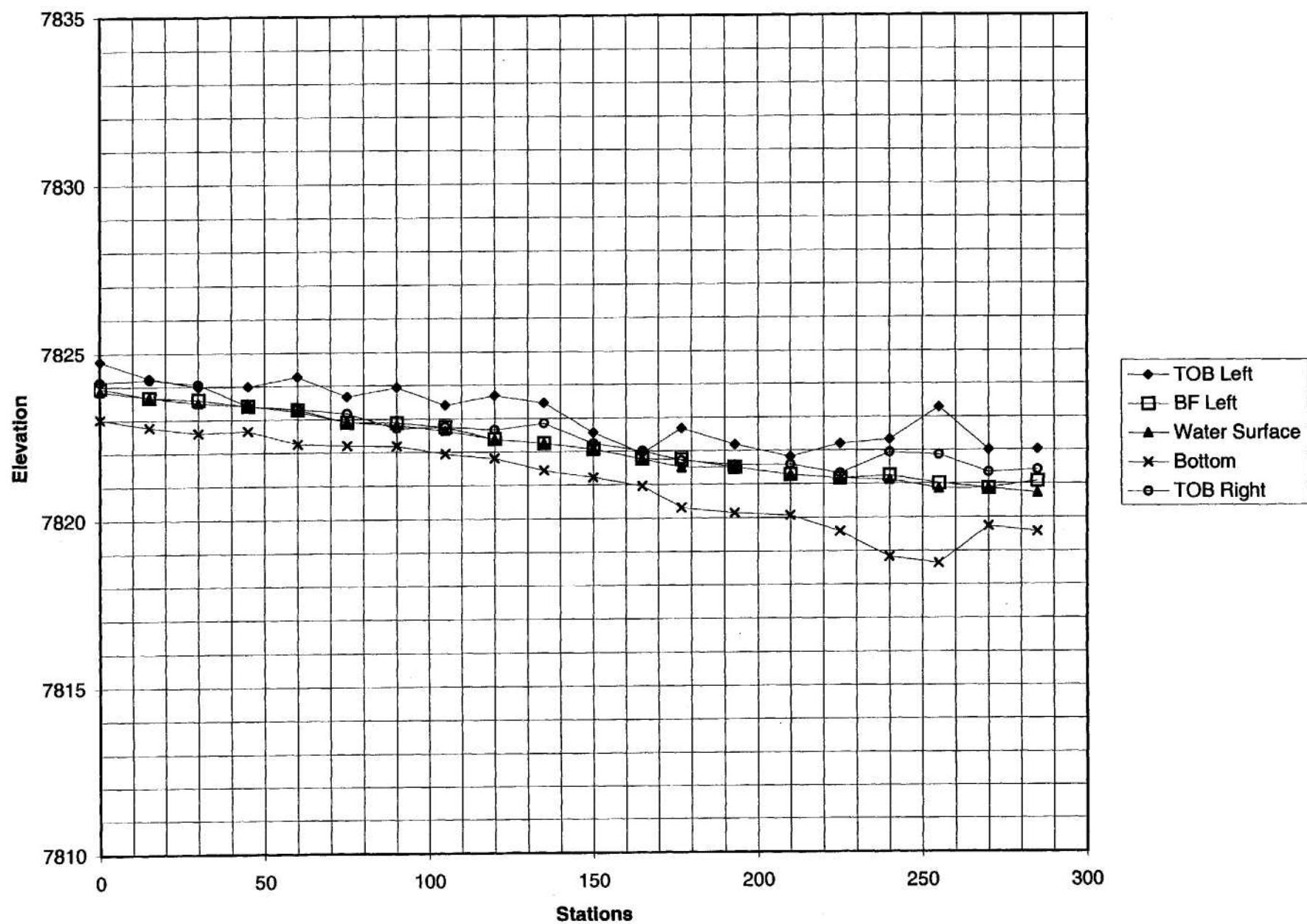
Max. Slope: 2.3 degrees
 Min. Slope: -3.6 degrees
 Ave Slope: 0.4 degrees

Cross-Section MC-2



Cross Section:	MC-2	Elev:	7827.037		Well I.D.s	El Change Ft	Distance Ft	Slope Degrees	
BenchMark1:		5.34	Rod Reading	Elevation					Water Levels
Station	Adj. Station								
-65.19	472.81			7830.82	7822.83	2c			
-14.6	523.4			7829.53	7822.59	2a	1.29	50.59	1
0	538	6.68		7825.697			3.833	14.6	15
3	541	8.55		7823.827			1.87	3	32
6	544	10.15		7822.227			1.6	3	28
7	545	10.39		7821.987			0.24	1	13
12	550	11.19		7821.187	7822.067		0.8	5	9
18	556	10.35		7822.027			-0.84	6	-8
19	557	10.29		7822.087			-0.06	1	-3
29	567	7.69		7824.687			-2.6	10	-15
39	577	6.78		7825.597	7821.83	2b	-0.91	10	-5

Profile MC-2



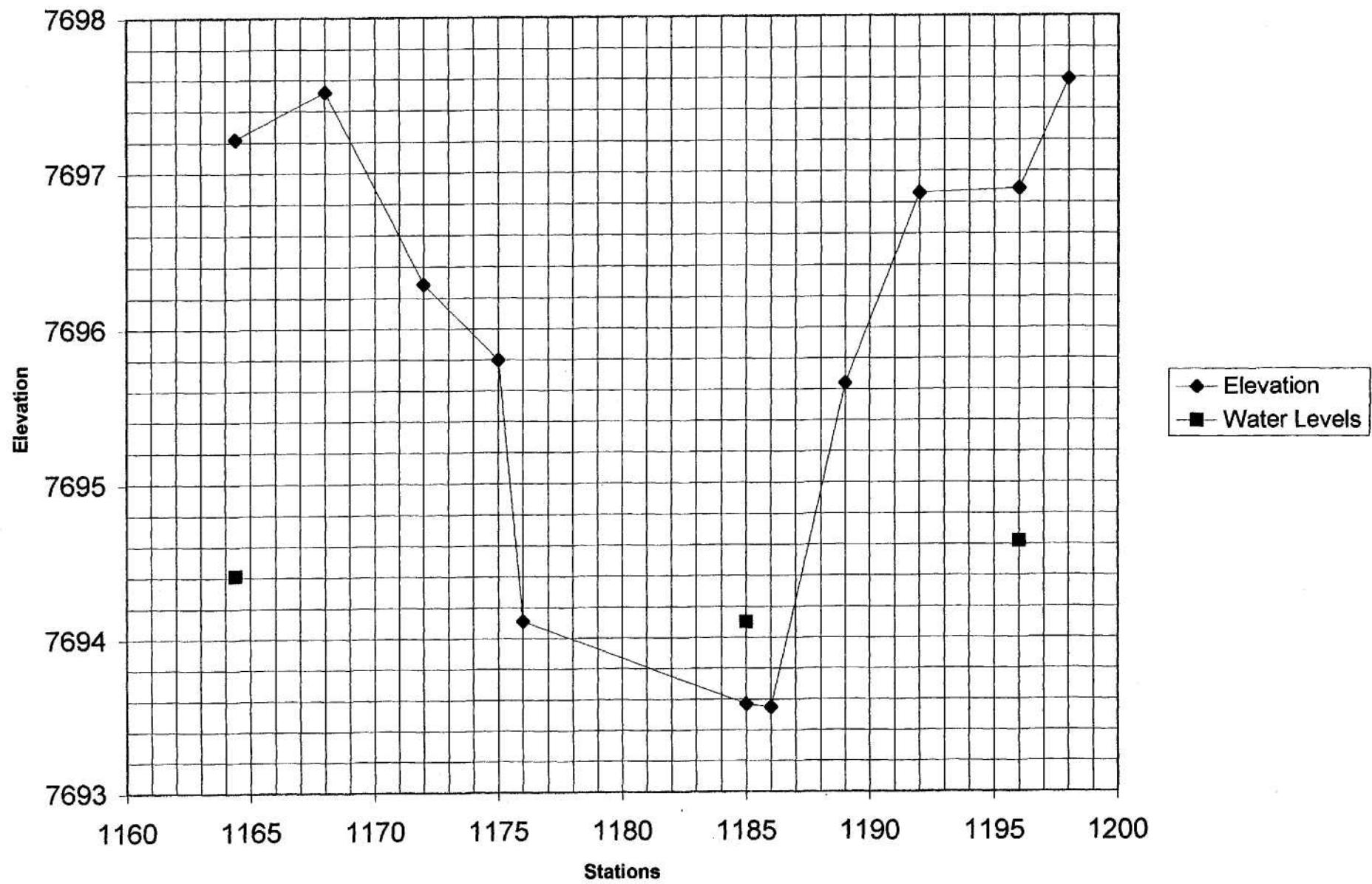
Profile: MC-2 BenchMark Elev:
BenchMark: 5.34

7827.037

Station	TOB Left		BF Left		Water Surface		Bottom		TOB Right		Elevation
	Rod Reading	Elevation	Rod Reading	Elevation	Rod Reading	Elevation	Rod Reading	Elevation	Rod Reading	Elevation	
0	7.62	7824.757	8.42	7823.957	8.52	7823.857	9.35	7823.027	8.24	7824.137	
15	8.13	7824.247	8.71	7823.667	8.71	7823.667	9.6	7822.777	8.17	7824.207	
30	8.4	7823.977	8.78	7823.597	8.88	7823.497	9.78	7822.597	8.32	7824.057	
45	8.39	7823.987	8.97	7823.407	8.97	7823.407	9.72	7822.657	8.96	7823.417	
60	8.11	7824.267	9.08	7823.297	9.15	7823.227	10.12	7822.257	9.07	7823.307	
75	8.71	7823.667	9.47	7822.907	9.47	7822.907	10.17	7822.207	9.21	7823.167	
90	8.44	7823.937	9.49	7822.887	9.56	7822.817	10.19	7822.187	9.67	7822.707	
105	8.98	7823.397	9.63	7822.747	9.74	7822.637	10.43	7821.947	9.62	7822.757	
120	8.7	7823.677	10	7822.377	10	7822.377	10.57	7821.807	9.72	7822.657	
135	8.92	7823.457	10.13	7822.247	10.13	7822.247	10.93	7821.447	9.53	7822.847	
150	9.82	7822.557	10.31	7822.067	10.31	7822.067	11.15	7821.227	10.14	7822.237	
165	10.44	7821.937	10.6	7821.777	10.6	7821.777	11.42	7820.957	10.37	7822.007	
177	9.7	7822.677	10.63	7821.747	10.86	7821.517	12.06	7820.317	10.65	7821.727	
193	10.19	7822.187	10.86	7821.517	10.86	7821.517	12.22	7820.157	10.79	7821.587	
210	10.56	7821.817	11.09	7821.287	11.09	7821.287	12.31	7820.067	10.79	7821.587	
225	10.18	7822.197	11.21	7821.167	11.21	7821.167	12.79	7819.587	11.05	7821.327	
240	10.05	7822.327	11.12	7821.257	11.25	7821.127	13.55	7818.827	10.44	7821.937	
255	9.09	7823.287	11.36	7821.017	11.52	7820.857	13.74	7818.637	10.51	7821.867	
270	10.37	7822.007	11.51	7820.867	11.51	7820.867	12.64	7819.737	11.03	7821.347	
285	10.35	7822.027	11.3	7821.077	11.65	7820.727	12.8	7819.577	10.95	7821.427	

Max. Slope: 3.1 degrees
 Min. Slope: -4.2 degrees
 Ave Slope: 0.7 degrees

Cross-section MC-3

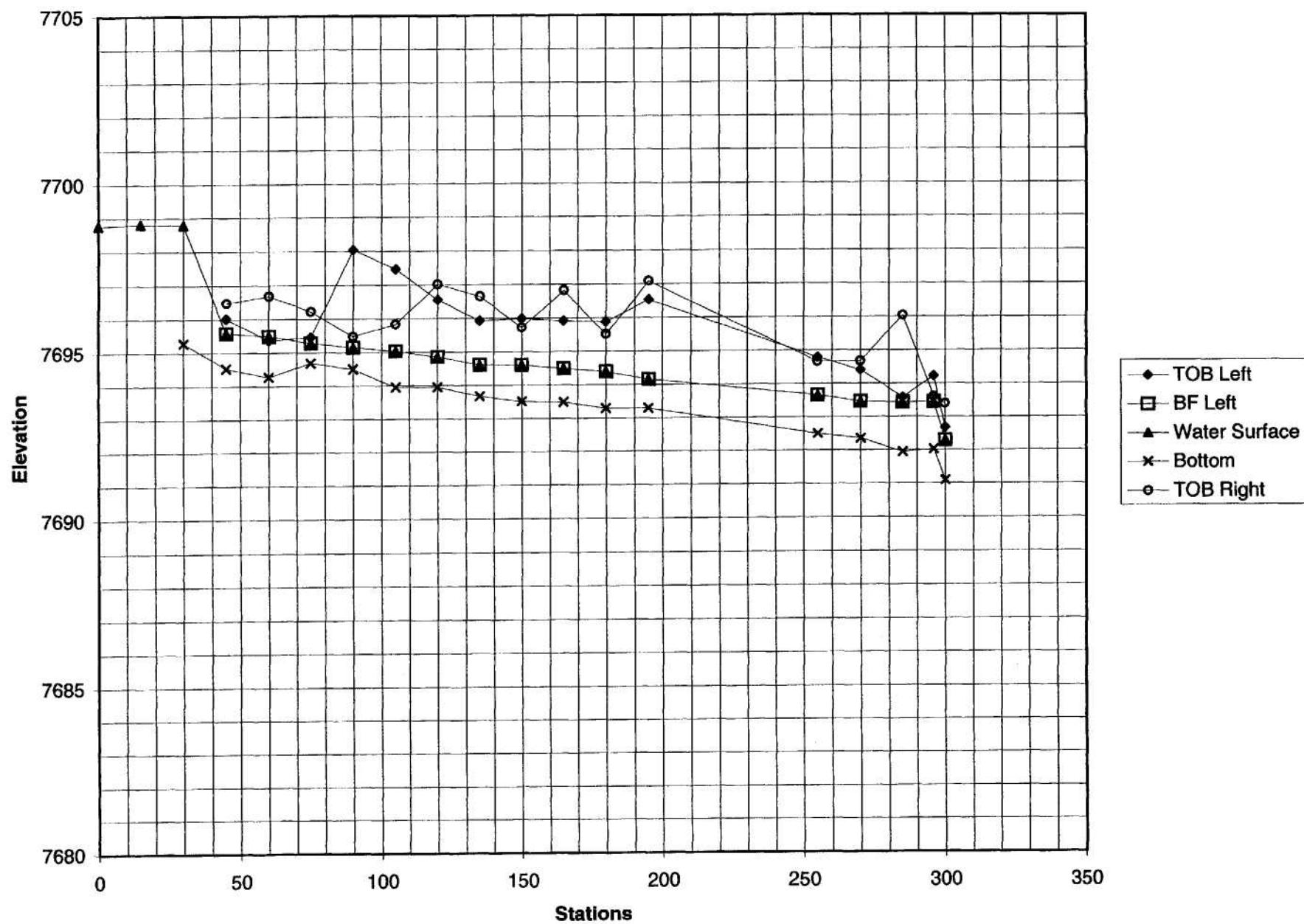


Cross Section: MC-3 Elev: 7698.23

BenchMark1: 7.53

Station	Adj. Station	Rod Reading	Elevation	Water Levels	Well I.D.s	El Change Ft	Distance Ft	Slope Degrees
-3.6	1164.4		7697.22	7694.41	3b			
0	1168	8.24	7697.52			-0.3	3.6	-5
4	1172	9.47	7696.29			1.23	4	17
7	1175	9.96	7695.8			0.49	3	9
8	1176	11.65	7694.11			1.69	1	59
17	1185	12.19	7693.57	7694.1		0.54	9	3
18	1186	12.21	7693.55			0.02	1	1
21	1189	10.12	7695.64			-2.09	3	-35
24	1192	8.9	7696.86			-1.22	3	-22
28	1196	8.87	7696.89	7694.62	3a	-0.03	4	0
30	1198	8.17	7697.59			-0.7	2	-19

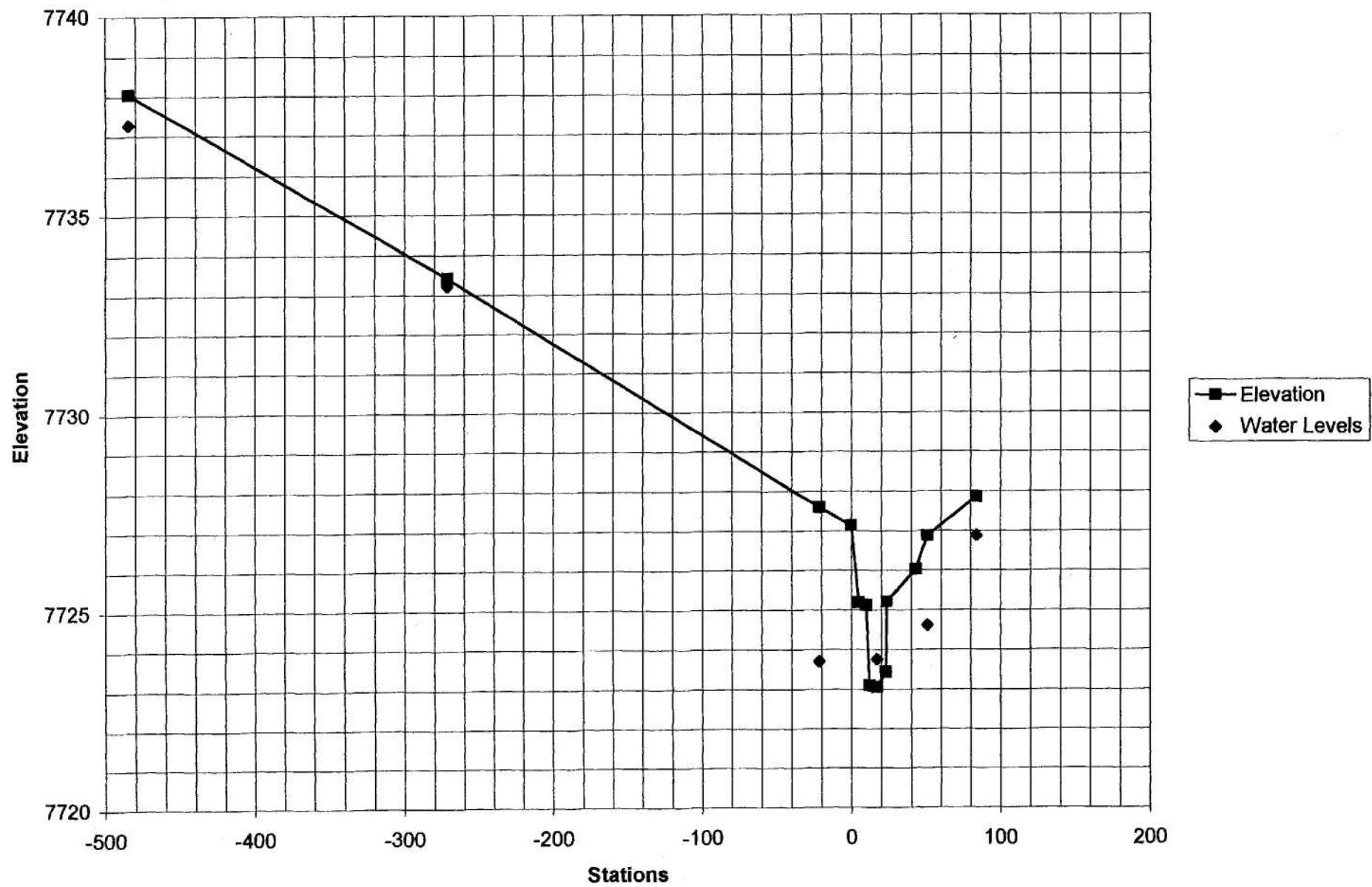
Profile MC-3



Profile:	MC-3	BenchMark Elev:	7698.232								
	BenchMark:		7.53								
Station	TOB Left Rod Reading	Elevation	BF Left Rod Reading	Elevation	Water Surface Rod Reading		Bottom Elevation	TOB Right Rod Reading			
0 -					6.99	7698.772 -					
15 -		-			6.95	7698.812 -					
30 -		-			6.97	7698.792	10.47	7695.292 -			
45	9.74	7696.022	10.18	7695.582	10.18	7695.582	11.23	7694.532	9.27	7696.492	
60	10.4	7695.362	10.27	7695.492	10.27	7695.492	11.49	7694.272	9.07	7696.692	
75	10.3	7695.462	10.48	7695.282	10.48	7695.282	11.08	7694.682	9.53	7696.232	
90	7.72	7698.042	10.61	7695.152	10.61	7695.152	11.26	7694.502	10.29	7695.472	
105	8.3	7697.462	10.73	7695.032	10.73	7695.032	11.81	7693.952	9.93	7695.832	
120	9.2	7696.562	10.91	7694.852	10.91	7694.852	11.81	7693.952	8.75	7697.012	
135	9.83	7695.932	11.15	7694.612	11.15	7694.612	12.09	7693.672	9.1	7696.662	
150	9.77	7695.992	11.16	7694.602	11.16	7694.602	12.25	7693.512	10.04	7695.722	
165	9.84	7695.922	11.27	7694.492	11.27	7694.492	12.28	7693.482	8.94	7696.822	
180	9.88	7695.882	11.37	7694.392	11.37	7694.392	12.47	7693.292	10.25	7695.512	
195	9.22	7696.542	11.6	7694.162	11.6	7694.162	12.47	7693.292	8.68	7697.082	
255	10.97	7694.792	12.1	7693.662	12.1	7693.662	13.26	7692.502	11.1	7694.662	
270	11.35	7694.412	12.3	7693.462	12.3	7693.462	13.41	7692.352	11.09	7694.672	
285	12.18	7693.582	12.33	7693.432	12.33	7693.432	13.82	7691.942	9.72	7696.042	
296	11.54	7694.222	12.31	7693.452	12.31	7693.452	13.74	7692.022	12.15	7693.612	
300	13.09	7692.672	13.47	7692.292	13.47	7692.292	14.67	7691.092	12.37	7693.392	

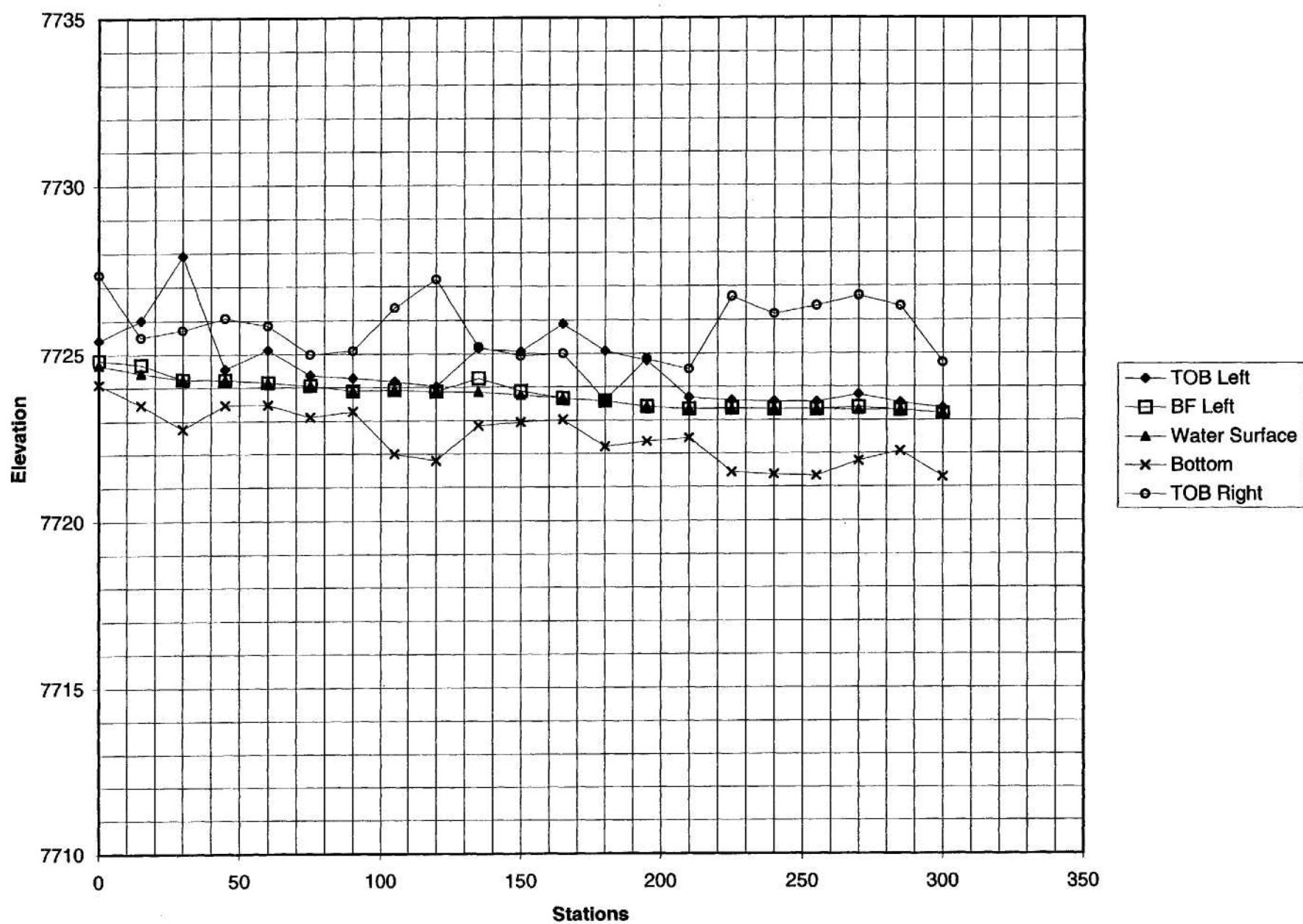
Max. Slope: 13.1 degrees
Min. Slope: -1.6 degrees
Ave Slope: 1.5 degrees

Cross-Section MC-4



Cross Section:	MC-4	Elev.:	7728.638		Well	I.D.s	El Change	Distance	Slope	
BenchMark1:		4.24	Rod Reading	Elevation						Water Levels
Station										
-484.65	338.35			7738.05	7737.28	4e				
-271.3	551.7			7733.41	7733.22	4d	4.64	213.35	1	
-21.7	801.3			7727.6	7723.71	4c	5.81	249.6	1	
0	823	5.73	7727.148				0.452	21.7	1	
5	828	7.69	7725.188				1.96	5	21	
10	833	7.76	7725.118				0.07	5	1	
12	835	9.78	7723.098				2.02	2	45	
17	840	9.82	7723.058	7723.76			0.04	5	0	
23	846	9.44	7723.438				-0.38	6	-4	
23.5	846.5	7.67	7725.208				-1.77	0.5	-74	
43	866	6.85	7726.028				-0.82	19.5	-2	
51	874	5.99	7726.888	7724.61		4b	-0.86	8	-6	
83.94	906.94		7727.86	7726.89		4a	-0.972	32.94	-2	

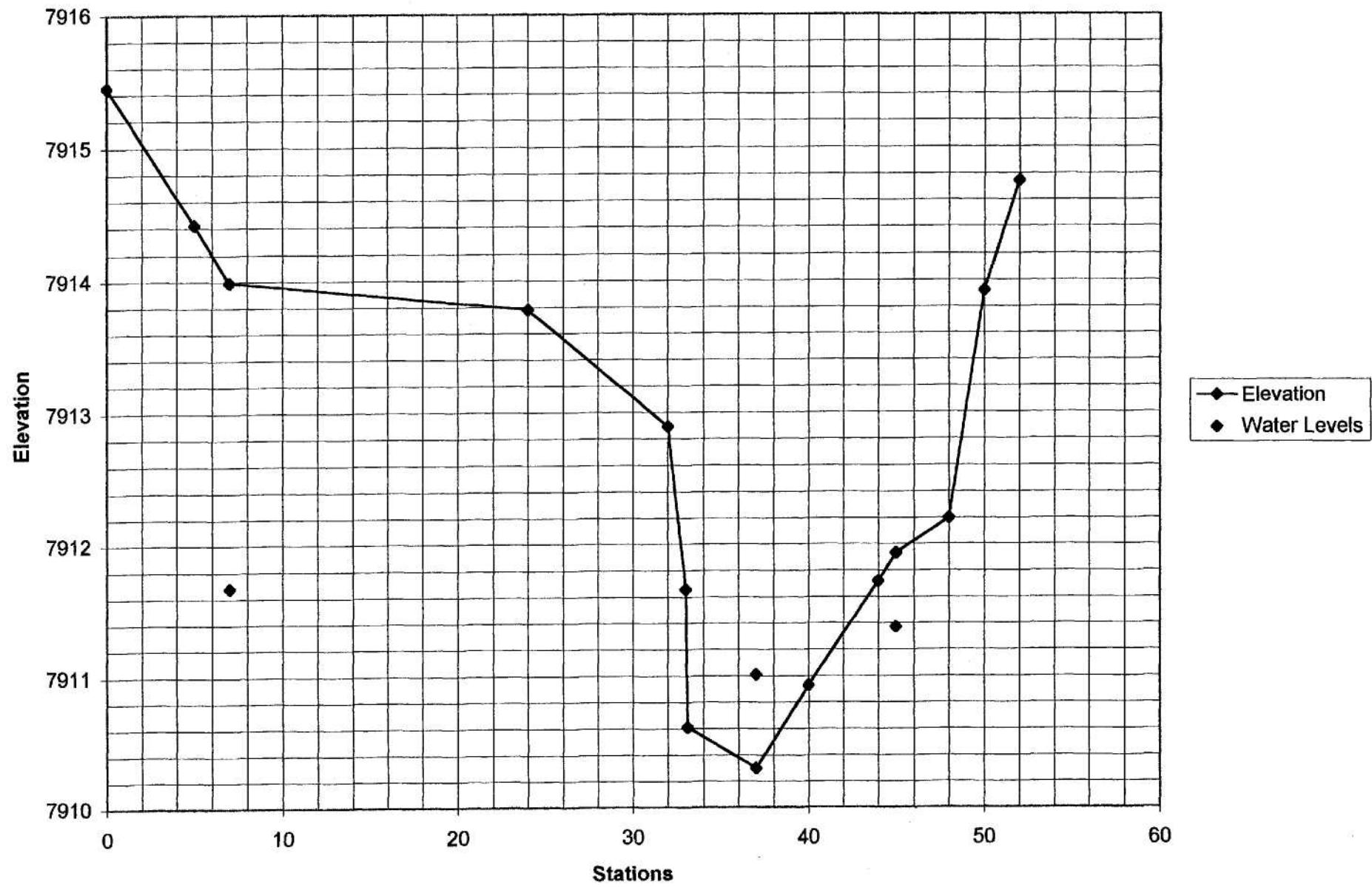
Profile MC-4



Profile:	MC-4	BenchMark Elev:	7728.638									
	BenchMark:	4.24										
Station	TOB Left	BF Left	Water Surface	Bottom	TOB Right							
	Rod Reading	Elevation	Rod Reading	Elevation	Rod Reading	Elevation	Rod Reading	Elevation	Rod Reading	Rod Reading	Elevation	
0	7.46	7725.418	8.05	7724.828	8.2	7724.678	8.78	7724.098	5.52	7727.358		
15	6.86	7726.018	8.19	7724.688	8.45	7724.428	9.4	7723.478	7.37	7725.508		
30	4.96	7727.918	8.64	7724.238	8.64	7724.238	10.11	7722.768	7.16	7725.718		
45	8.33	7724.548	8.65	7724.228	8.65	7724.228	9.4	7723.478	6.8	7726.078		
60	7.75	7725.128	8.74	7724.138	8.74	7724.138	9.4	7723.478	7.03	7725.848		
75	8.52	7724.358	8.83	7724.048	8.83	7724.048	9.77	7723.108	7.89	7724.988		
90	8.6	7724.278	8.99	7723.888	8.99	7723.888	9.6	7723.278	7.78	7725.098		
105	8.71	7724.168	8.96	7723.918	8.96	7723.918	10.88	7721.998	6.5	7726.378		
120	8.86	7724.018	9.01	7723.868	9.01	7723.868	11.08	7721.798	5.67	7727.208		
135	7.72	7725.158	8.62	7724.258	9.03	7723.848	10.02	7722.858	7.67	7725.208		
150	7.81	7725.068	9	7723.878	9.12	7723.758	9.92	7722.958	7.94	7724.938		
165	6.99	7725.888	9.22	7723.658	9.22	7723.658	9.85	7723.028	7.87	7725.008		
180	7.8	7725.078	9.3	7723.578	9.3	7723.578	10.67	7722.208	9.29	7723.588		
195	8.08	7724.798	9.47	7723.408	9.47	7723.408	10.51	7722.368	8.04	7724.838		
210	9.2	7723.678	9.54	7723.338	9.54	7723.338	10.4	7722.478	8.35	7724.528		
225	9.29	7723.588	9.52	7723.358	9.55	7723.328	11.44	7721.438	6.18	7726.698		
240	9.32	7723.558	9.55	7723.328	9.55	7723.328	11.51	7721.368	6.7	7726.178		
255	9.34	7723.538	9.55	7723.328	9.55	7723.328	11.55	7721.328	6.45	7726.428		
270	9.12	7723.758	9.5	7723.378	9.58	7723.298	11.1	7721.778	6.17	7726.708		
285	9.36	7723.518	9.58	7723.298	9.58	7723.298	10.81	7722.068	6.46	7726.418		
300	9.52	7723.358	9.68	7723.198	9.68	7723.198	11.59	7721.288	8.15	7724.728		

Max. Slope: 4.9 degrees
 Min. Slope: -4.0 degrees
 Ave Slope: 0.4 degrees

Cross-Section MC-5

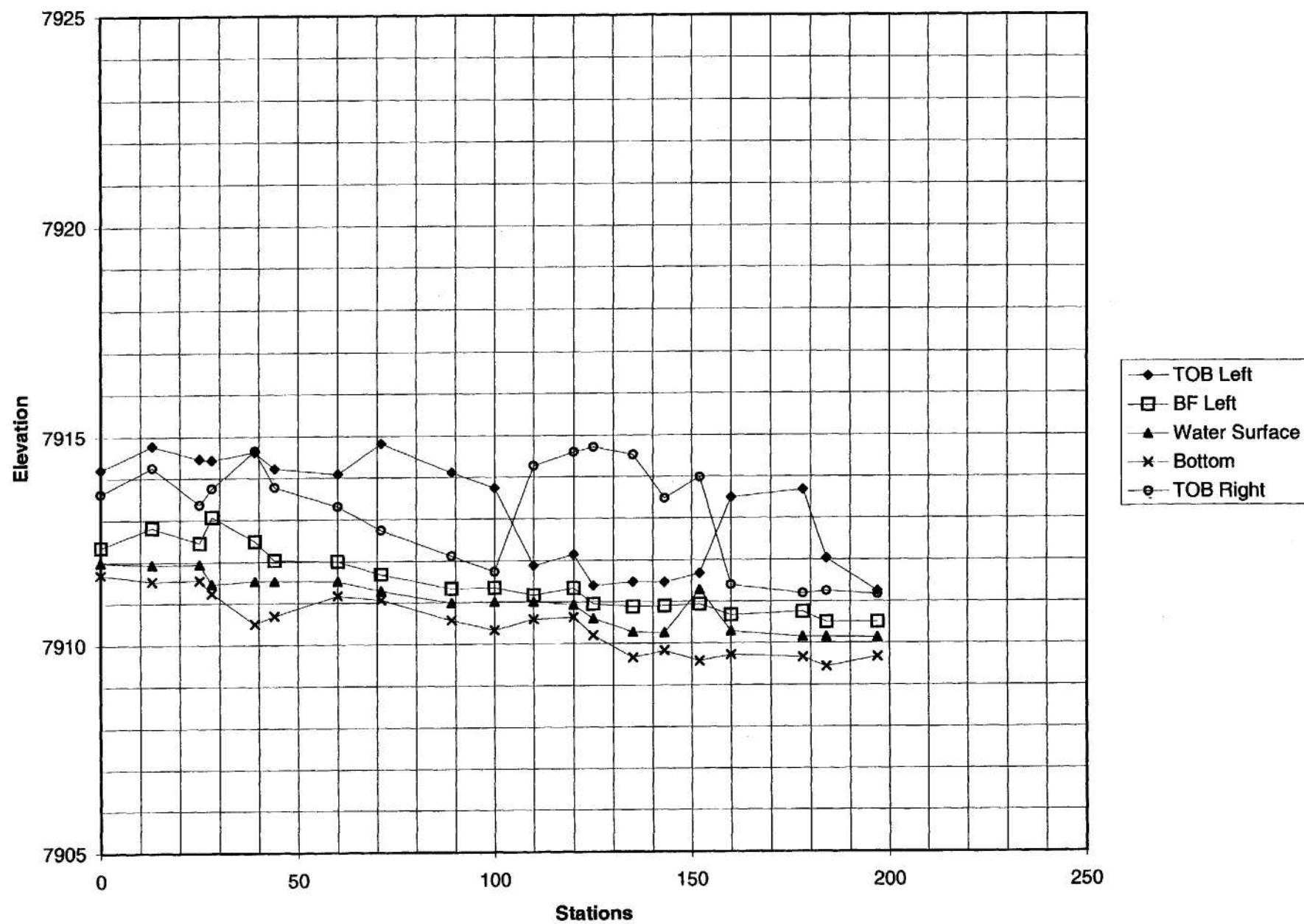


Cross Section: MC-5 Elev.: 7915.351

BenchMark1: 1.4

Station	Rod Reading	Elevation	Water Levels	Well I.D.s	El Change Ft	Distance Ft	Slope Degrees
0	1.3	7915.451			1.03	5	12
5	2.33	7914.421			0.43	2	12
7	2.76	7913.991	7911.68	5b	0.21	17	1
24	2.97	7913.781			0.89	8	6
32	3.86	7912.891			1.23	1	51
33	5.09	7911.661			1.05	0.1	85
33.1	6.14	7910.611			0.31	3.9	5
37	6.45	7910.301	7911.011		-0.63	3	-12
40	5.82	7910.931			-0.79	4	-11
44	5.03	7911.721			-0.21	1	-12
45	4.82	7911.931	7911.37	5a	-0.27	3	-5
48	4.55	7912.201			-1.72	2	-41
50	2.83	7913.921			-0.82	2	-22
52	2.01	7914.741					

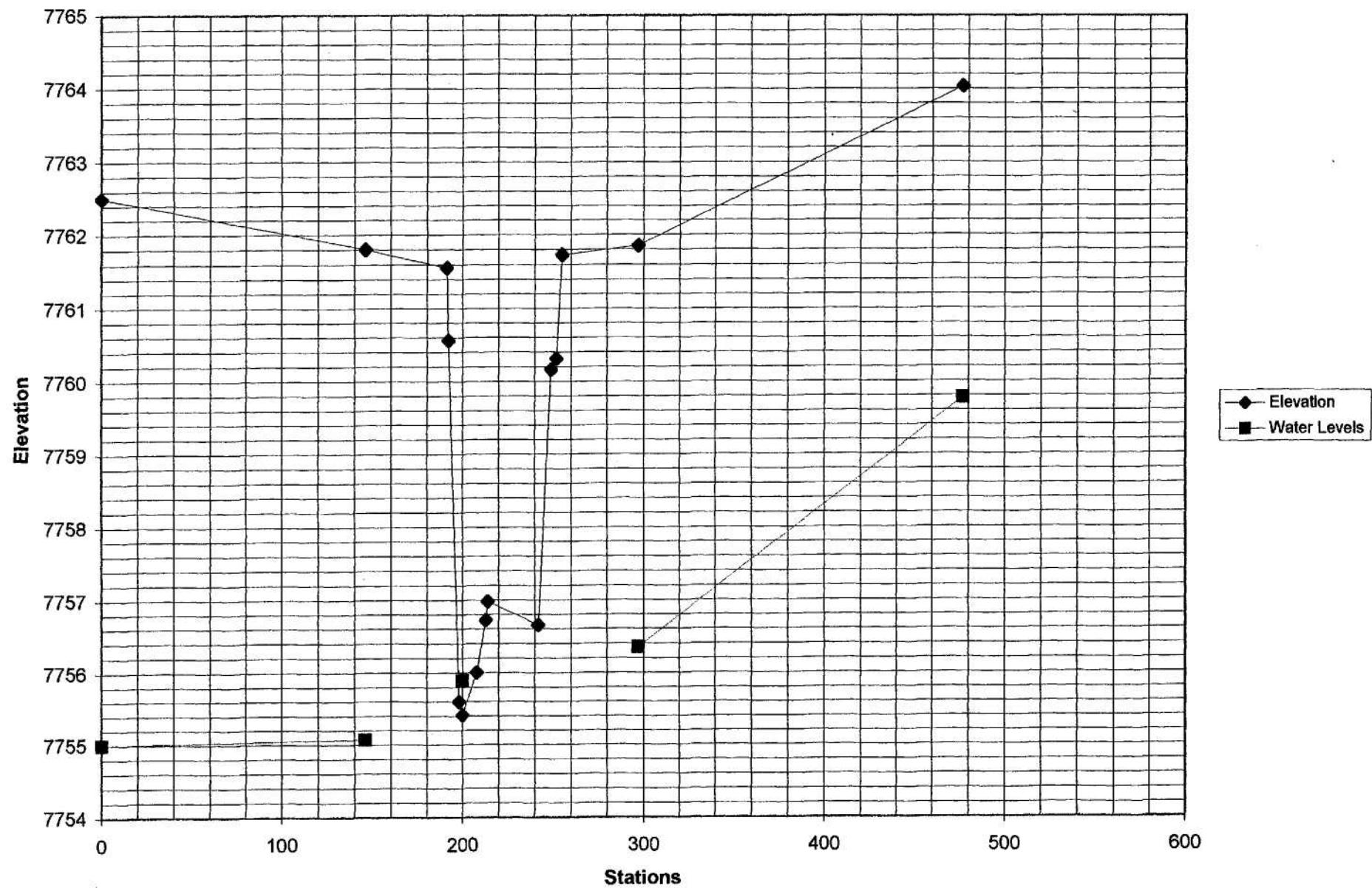
Profile MC-5



Profile:	MC-5	BenchMark Elev:	7915.351									
	BenchMark:	1.4										
Station	TOB Left		BF Left		Water Surface		Bottom		TOB Right		Elevation	
	Rod Reading	Elevation	Rod Reading	Elevation	Rod Reading	Elevation	Rod Reading	Elevation	Rod Reading	Elevation		
0	2.55	7914.201	4.4	7912.351	4.76	7911.991	5.06	7911.691	3.13	7913.621		
13	1.98	7914.771	3.93	7912.821	4.82	7911.931	5.22	7911.531	2.5	7914.251		
25	2.29	7914.461	4.3	7912.451	4.81	7911.941	5.2	7911.551	3.39	7913.361		
28	2.32	7914.431	3.68	7913.071	5.29	7911.461	5.51	7911.241	3	7913.751		
39	2.13	7914.621	4.26	7912.491	5.22	7911.531	6.25	7910.501	2.1	7914.651		
44	2.53	7914.221	4.72	7912.031	5.22	7911.531	6.06	7910.691	2.98	7913.771		
60	2.67	7914.081	4.75	7912.001	5.23	7911.521	5.58	7911.171	3.45	7913.301		
71	1.94	7914.811	5.07	7911.681	5.47	7911.281	5.68	7911.071	4.01	7912.741		
89	2.64	7914.111	5.42	7911.331	5.76	7910.991	6.18	7910.571	4.63	7912.121		
100	3.02	7913.731	5.4	7911.351	5.74	7911.011	6.42	7910.331	5.01	7911.741		
110	4.87	7911.881	5.58	7911.171	5.74	7911.011	6.16	7910.591	2.48	7914.271		
120	4.61	7912.141	5.42	7911.331	5.82	7910.931	6.12	7910.631	2.16	7914.591		
125	5.36	7911.391	5.8	7910.951	6.15	7910.601	6.56	7910.191	2.04	7914.711		
135	5.27	7911.481	5.87	7910.881	6.48	7910.271	7.08	7909.671	2.23	7914.521		
143	5.28	7911.471	5.85	7910.901	6.5	7910.251	6.92	7909.831	3.28	7913.471		
152	5.07	7911.681	5.81	7910.941	5.46	7911.291	7.17	7909.581	2.77	7913.981		
160	3.26	7913.491	6.08	7910.671	6.47	7910.281	7.02	7909.731	5.35	7911.401		
178	3.08	7913.671	6	7910.751	6.6	7910.151	7.08	7909.671	5.56	7911.191		
184	4.72	7912.031	6.25	7910.501	6.6	7910.151	7.3	7909.451	5.5	7911.251		
197	5.5	7911.251	6.25	7910.501	6.62	7910.131	7.07	7909.681	5.58	7911.171		

Max. Slope: 5.9 degrees
 Min. Slope: -2.2 degrees
 Ave Slope: 0.9 degrees

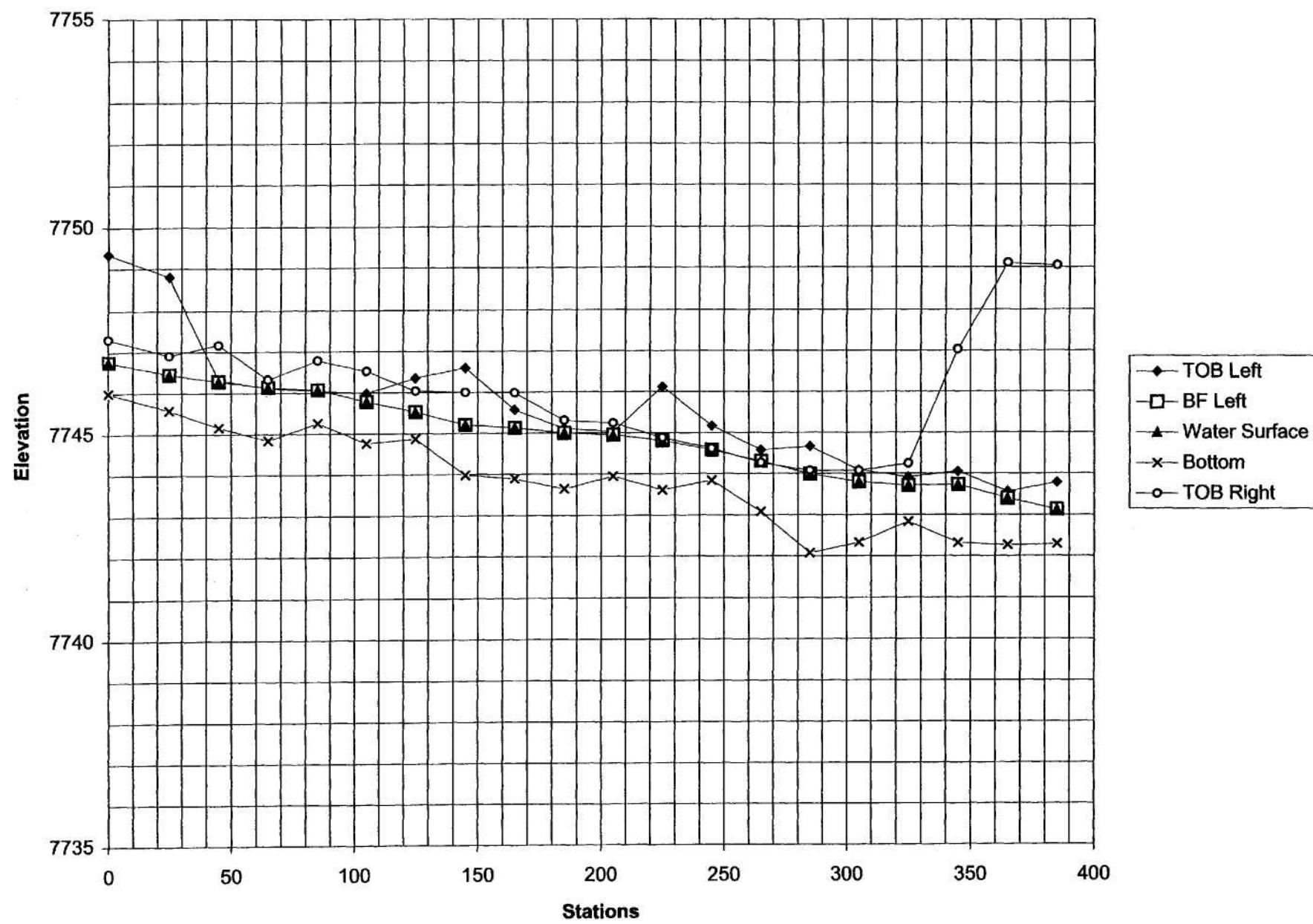
Cross-section MC-6



Cross Section: MC-6 Elev.: 7763.84

Station	Rod Reading	Elevation	Water Levels	Well		El Change Ft	Distance Ft	Slope Degrees
				I.D.s	Ft			
0	4.23	7762.5	7755	6d				
146	4.92	7761.81	7755.07	6c	0.69	146	0	
191	5.5	7761.56			0.25	45	0	
192	6.5	7760.56			1	1	45	
198	11.46	7755.6			4.96	6	40	
200	11.65	7755.41	7755.89		0.19	2	5	
208	11.05	7756.01			-0.6	8	-4	
213	10.34	7756.72			-0.71	5	-8	
214	10.08	7756.98			-0.26	1	-15	
242	10.41	7756.65			0.33	28	1	
249	6.9	7760.16			-3.51	7	-27	
252	6.75	7760.31			-0.15	3	-3	
255	5.33	7761.73			-1.42	3	-25	
297	4.88	7761.85	7756.35	6b	-0.12	42	0	
477	2.7	7764.03	7759.77	6a	-2.18	180	-1	

Profile MC-6



Profile:	MC-6	BenchMark Elev:		7752.14									
	BenchMark:	3.22											
Station	TOB Left		BF Left		Water Surface		Bottom		TOB Right				
	Rod Reading	Elevation	Rod Reading	Elevation	Rod Reading	Elevation	Rod Reading	Elevation	Rod Reading	Elevation	Rod Reading	Elevation	
0	6.02	7749.34	8.61	7746.75	8.61	7746.75	9.37	7745.99	8.05	7747.31			
25	6.56	7748.8	8.91	7746.45	8.91	7746.45	9.78	7745.58	8.45	7746.91			
45	9.04	7746.32	9.08	7746.28	9.08	7746.28	10.2	7745.16	8.19	7747.17			
65	9.25	7746.11	9.23	7746.13	9.23	7746.13	10.52	7744.84	9.04	7746.32			
85	9.31	7746.05	9.29	7746.07	9.29	7746.07	10.1	7745.26	8.58	7746.78			
105	9.38	7745.98	9.58	7745.78	9.58	7745.78	10.6	7744.76	8.84	7746.52			
125	9.01	7746.35	9.83	7745.53	9.83	7745.53	10.49	7744.87	9.32	7746.04			
145	8.77	7746.59	10.15	7745.21	10.15	7745.21	11.38	7743.98	9.36	7746			
165	9.79	7745.57	10.23	7745.13	10.23	7745.13	11.47	7743.89	9.38	7745.98			
185	10.25	7745.11	10.36	7745	10.36	7745	11.72	7743.64	10.05	7745.31			
205	10.33	7745.03	10.41	7744.95	10.41	7744.95	11.42	7743.94	10.12	7745.24			
225	9.24	7746.12	10.55	7744.81	10.55	7744.81	11.75	7743.61	10.48	7744.88			
245	10.19	7745.17	10.78	7744.58	10.78	7744.58	11.52	7743.84	10.74	7744.62			
265	10.78	7744.58	11.05	7744.31	11.05	7744.31	12.28	7743.08	11.09	7744.27			
285	10.7	7744.66	11.37	7743.99	11.37	7743.99	13.29	7742.07	11.29	7744.07			
305	11.27	7744.09	11.56	7743.8	11.56	7743.8	13.03	7742.33	11.29	7744.07			
325	11.45	7743.91	11.65	7743.71	11.65	7743.71	12.52	7742.84	11.11	7744.25			
345	11.31	7744.05	11.63	7743.73	11.63	7743.73	13.04	7742.32	8.33	7747.03			
365	11.8	7743.56	11.96	7743.4	11.96	7743.4	13.1	7742.26	6.26	7749.1			
385	11.58	7743.78	12.23	7743.13	12.23	7743.13	13.07	7742.29	6.32	7749.04			
405	11.71	7743.65	12.25	7743.11	12.25	7743.11	13.13	7742.23	11.38	7743.98			
425	11.95	7743.41	12.42	7742.94	12.42	7742.94	14.55	7740.81	12.3	7743.06			
450	11.9	7743.46	12.46	7742.9	12.46	7742.9	13.25	7742.11	11.83	7743.53			

Max. Slope: 4.1 degrees

Min. Slope: -3.0 degrees

Ave Slope: 0.5 degrees

Canyon Fuel Company
Skyline Mine

Mine-Water Discharge Impact
December 2002

APPENDIX F

Streamflow Data Tabulations

NWIS Data

Water Resources

Data Category:

Surface Water

Geographic Area:

United States

GO

Daily Streamflow Statistics for the Nation

USGS 09310600 ECCLES CANYON NEAR SCOFIELD, UTAH

Available data for this site

Surface-water: Daily streamflow statistics

GO

Carbon County, Utah

Hydrologic Unit Code 14060005

Latitude 39°41'07", Longitude 111°09'43" NAD27

Drainage area 5.50 square miles

Gage datum 7,980 feet above sea level NGVD29

Output formats[HTML table of all data](#)[Tab-separated data](#)[Reselect output format](#)

Day of month	Mean of daily mean values for this day for 5 years of record ¹ , in ft ³ /s											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	1.38	1.42	1.74	1.90	6.88	25.1	7.26	3.24	2.48	2.48	1.64	1.51
2	1.36	1.30	1.66	1.70	7.94	24.7	6.90	3.08	2.24	1.94	1.60	1.57
3	1.49	1.36	1.66	1.58	8.36	23.9	6.76	3.12	2.18	2.02	1.70	1.51
4	1.62	1.42	1.60	1.54	8.66	23.4	6.34	2.90	2.40	1.90	1.82	1.49
5	1.60	1.40	1.58	1.60	8.60	24.0	5.88	2.88	2.32	2.00	1.76	1.55
6	1.54	1.41	1.58	1.78	8.78	24.1	5.78	2.82	2.16	1.78	1.66	1.49
7	1.58	1.48	1.62	1.80	8.04	23.3	5.44	2.78	2.30	1.68	1.68	1.47
8	1.47	1.46	1.66	1.86	8.56	22.7	5.28	3.06	2.56	1.82	1.70	1.59
9	1.47	1.56	1.76	2.20	9.80	22.1	5.34	2.78	2.56	1.64	1.54	1.51
10	1.35	1.50	1.71	2.12	9.90	22.3	5.26	2.84	2.52	1.65	1.52	1.47
11	1.42	1.46	1.71	2.32	9.74	23.6	4.82	3.00	2.36	1.97	1.56	1.43
12	1.40	1.56	1.71	2.32	10.9	23.0	4.68	2.84	2.24	1.83	1.58	1.43
13	1.40	1.58	1.70	2.50	12.1	21.2	4.66	2.88	2.46	1.77	1.48	1.49
14	1.47	1.60	1.78	2.62	13.1	19.6	4.28	2.68	2.20	1.71	1.38	1.55
15	1.47	1.48	1.76	2.94	14.7	17.6	4.08	2.70	2.12	1.78	1.36	1.57
16	1.42	1.48	1.72	3.32	14.4	16.9	4.08	2.66	2.22	1.76	1.54	1.58
17	1.44	1.58	1.68	4.10	13.5	16.5	3.90	2.60	2.14	1.76	1.50	1.58
18	1.36	1.56	1.68	4.14	14.1	16.9	3.66	2.52	2.10	1.78	1.54	1.56
19	1.36	1.50	1.64	4.58	14.4	15.7	3.56	3.02	2.08	1.76	1.44	1.54
20	1.40	1.40	1.60	3.68	15.8	14.5	3.42	2.50	2.20	1.94	1.37	1.56

21	1.40	1.48	1.64	3.58	18.9	13.7	3.32	2.52	2.38	1.80	1.39	1.54	
22	1.38	1.52	1.74	3.76	20.9	12.5	3.50	2.68	2.40	1.70	1.47	1.54	
23	1.48	1.50	1.80	4.60	23.7	11.9	3.64	2.56	2.40	1.58	1.35	1.52	
24	1.56	1.58	1.80	5.10	27.3	11.1	3.44	2.40	2.40	1.56	1.45	1.48	
25	1.60	1.62	1.82	5.86	29.1	10.2	3.42	2.48	2.48	1.64	1.51	1.44	
26	1.60	1.58	1.96	5.62	28.6	9.60	3.56	2.50	2.84	1.74	1.43	1.36	
27	1.54	1.60	1.90	6.04	28.1	9.06	3.92	2.58	3.02	1.82	1.35	1.38	
28	1.52	1.58	1.80	6.22	28.3	8.46	3.46	2.36	2.84	1.70	1.51	1.36	
29	1.50	1.70	1.86	6.78	27.3	7.98	3.40	2.36	2.90	1.74	1.63	1.32	
30	1.45		1.96	6.62	28.3	7.58	3.38	2.38	3.22	1.72	1.57	1.26	
31	1.40			2.06		26.5		3.40	2.36		1.68		1.35

1 -- Available period of record may be less than value shown for certain days of the year.

Questions about data h2oteam@usgs.gov

Feedback on this website nwisweb@usgs.gov

Surface Water data for USA: Daily Streamflow Statistics

<http://waterdata.usgs.gov/nwis/dvstat?>

[Return to top of page](#)

Retrieved on 2002-12-31 16:03:36 EST

[Department of the Interior, U.S. Geological Survey](#)

[Privacy Statement](#) || [Disclaimer](#) || [Accessibility](#)

0.79 0.76

Water Resources

Data Category:

Surface Water

Geographic Area:

United States

GO

Daily Streamflow Statistics for the Nation

**USGS 09310700 MUD CREEK BL WINTER QUARTERS CANYON AT
SCOFIELD, UT**

Available data for this site GO

Carbon County, Utah

Hydrologic Unit Code 14060007

Latitude 39°43'18", Longitude 111°09'38" NAD27

Drainage area 29.10 square miles

Gage datum 7,720.0 feet above sea level NGVD29

Output formats

[HTML table of all data](#)[Tab-separated data](#)[Reselect output format](#)

Day of month	Mean of daily mean values for this day for 21 years of record ¹ , in ft ³ /s											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	5.73	5.27	6.82	11.5	30.0	75.6	20.1	8.82	7.66	7.39	7.18	6.34
2	5.64	5.33	6.87	11.5	32.9	73.1	19.1	8.56	7.91	7.57	7.27	6.23
3	5.69	5.45	6.96	10.8	35.7	70.1	18.6	8.42	7.90	7.80	7.31	6.27
4	5.76	5.58	7.08	10.8	37.2	67.7	17.1	8.12	7.84	7.51	7.26	6.22
5	5.79	5.55	7.11	11.2	37.7	66.4	16.4	7.98	7.60	7.16	7.22	6.14
6	5.68	5.45	7.34	11.7	39.0	66.4	15.2	7.91	7.93	6.97	6.92	6.13
7	5.75	5.56	7.69	12.0	37.3	63.1	14.7	7.76	7.76	7.53	7.03	6.15
8	5.79	5.47	7.64	12.1	38.0	60.2	14.3	7.96	7.96	7.59	7.01	6.19
9	5.97	5.51	7.70	13.0	39.7	58.1	14.0	7.82	8.08	7.05	6.86	6.20
10	5.91	5.53	7.69	13.3	40.1	56.1	13.8	8.53	8.06	6.97	6.65	6.07
11	5.73	5.58	7.74	13.6	40.7	55.0	13.1	8.66	8.50	7.43	6.58	5.94
12	5.77	5.69	7.71	14.0	43.2	53.8	12.6	8.11	8.68	7.37	6.57	5.94
13	5.82	6.01	7.55	14.1	43.8	52.5	12.3	7.90	8.53	6.85	6.58	5.93
14	5.85	6.15	7.61	14.4	46.4	50.3	11.6	7.85	8.13	6.99	6.62	5.95
15	5.93	6.08	7.75	15.3	50.2	47.9	11.5	8.05	7.97	6.95	6.68	5.93
16	5.74	6.09	8.06	16.3	53.5	45.1	11.3	7.94	8.13	7.14	6.56	5.95
17	5.66	6.14	7.92	17.4	55.8	43.6	11.1	7.75	8.07	7.17	6.58	5.85
18	5.67	6.13	8.08	18.2	59.1	41.7	11.0	7.80	8.52	7.48	6.63	5.75
19	5.79	6.25	8.35	18.2	60.2	39.3	11.1	8.17	8.68	7.41	6.82	5.74

20	5.88	6.16	8.44	18.1	64.0	37.1	11.3	7.89	7.83	7.27	6.40	5.77
21	5.78	6.24	8.79	18.5	71.4	35.3	11.5	8.01	8.00	7.24	6.46	5.78
22	5.79	6.28	8.87	19.4	74.7	33.0	11.2	7.77	7.51	7.33	6.66	5.85
23	5.62	6.22	9.15	21.1	76.9	30.9	11.0	7.85	7.64	7.76	6.39	5.80
24	5.68	6.36	9.23	22.5	81.0	29.3	10.5	7.70	8.19	7.78	6.48	5.76
25	5.67	6.55	9.34	22.9	81.6	28.5	10.0	7.82	7.91	7.29	6.54	5.77
26	5.81	6.46	9.31	22.6	79.3	26.3	10.3	7.72	8.19	7.65	6.45	5.69
27	5.63	6.54	9.53	23.6	79.5	25.0	10.1	7.95	8.23	7.46	6.34	5.68
28	5.58	6.61	9.78	25.1	81.0	23.3	9.63	7.72	8.13	7.57	6.39	5.69
29	5.46	7.10	10.2	27.2	79.0	22.1	9.23	7.61	8.38	7.24	6.43	5.63
30	5.36		10.9	27.8	80.4	20.9	9.73	7.70	8.61	7.25	6.41	5.54
31	5.36		11.6		79.2		9.15	7.90		7.25		5.59

1 -- Available period of record may be less than value shown for certain days of the year.

Questions about data h2oteam@usgs.gov

Feedback on this website egs-w_support_nwisweb@usgs.gov

[Return to top of page](#)

Surface Water data for USA: Daily Streamflow Statistics

<http://waterdata.usgs.gov/nwis/dvstat?>

Retrieved on 2002-12-31 16:05:17 EST

[Department of the Interior, U.S. Geological Survey](#)

[Privacy Statement](#) || [Disclaimer](#) || [Accessibility](#)

0.76 0.75

Canyon Fuel Company
Skyline Mine

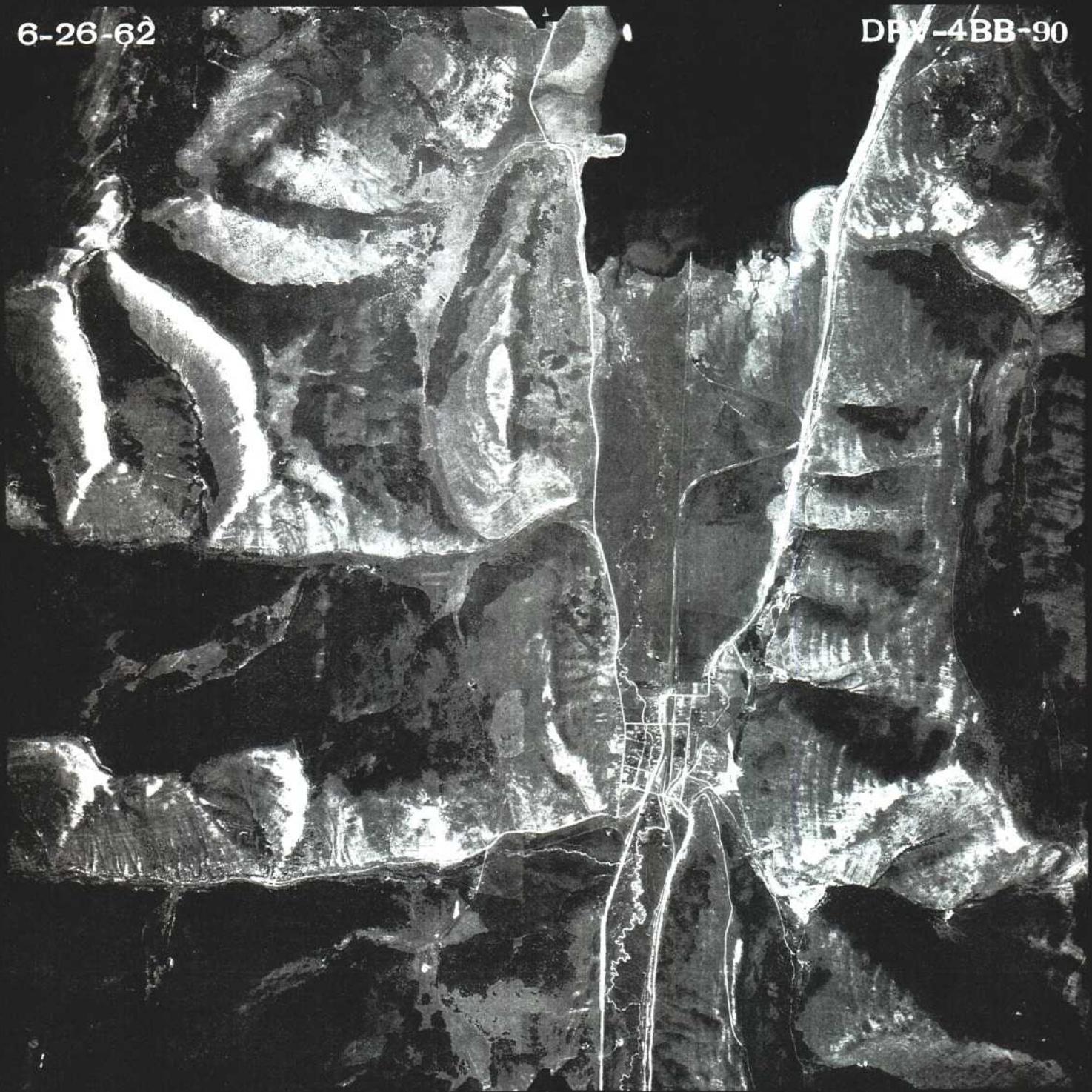
Mine-Water Discharge Impact
December 2002

APPENDIX G

Aerial Photographs

6-26-62

DRV-4BB-90



6-26-62

DRV 4BB- 88



6-22 80

USDA

40 49007

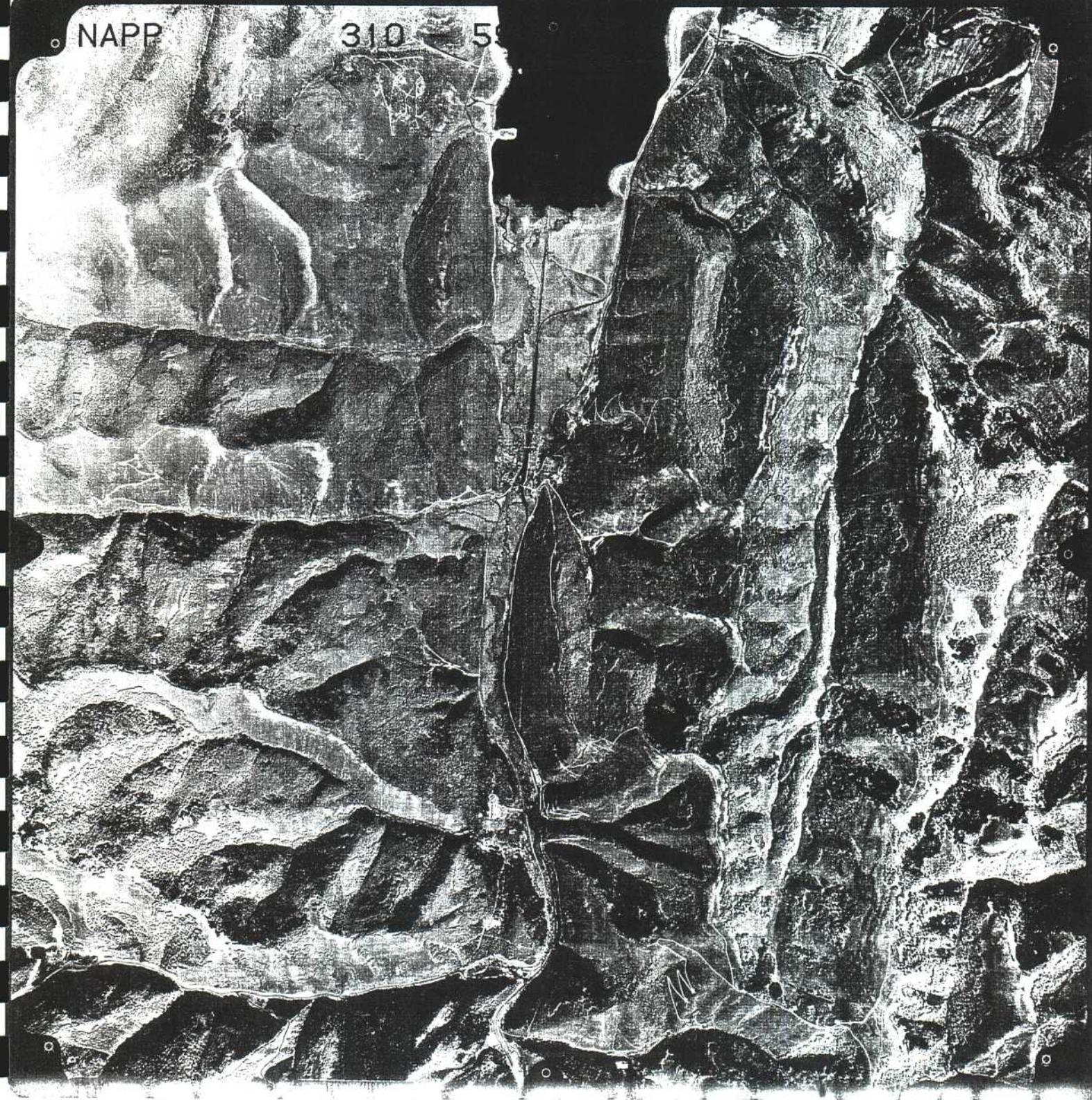
279- 43

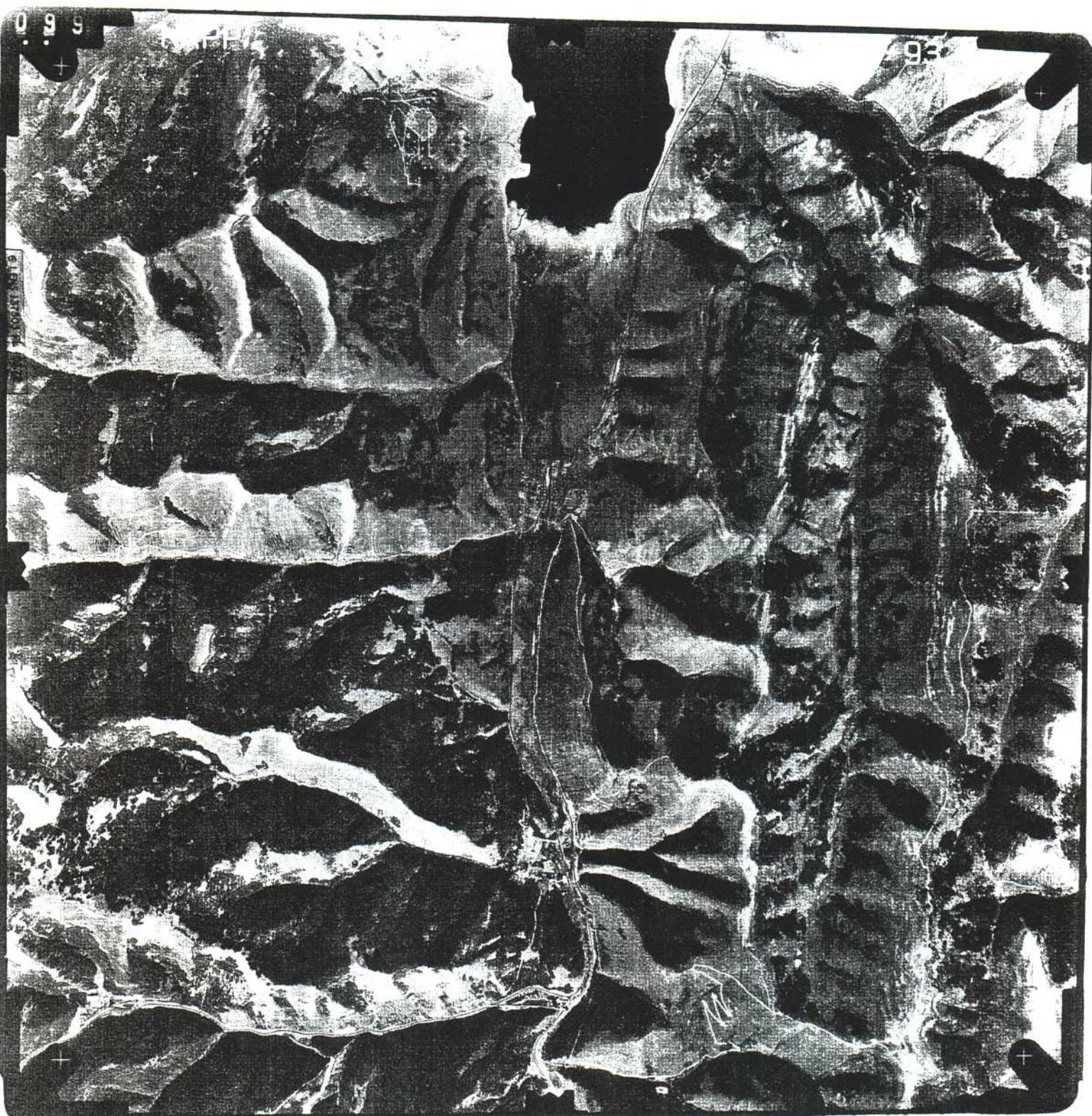


NAPP

310

59





NAPP

10097-230

J-30-9

2-3 1

Canyon Fuel Company
Skyline Mine

Mine-Water Discharge Impact
December 2002

APPENDIX H

Erosional Stability Analyses

EROSIONAL STABILITY OF MUD CREEK

- Determine allowable velocity according to US Soil Conservation Service (1977) for channel bed and Haan et al. (1994) for channel banks
- Evaluate stability under both sediment-laden and sediment-free conditions at flows varying from 5,000 to 30,000 gpm (11.1 to 66.9 cfs)
- Evaluate stability of the stream bank and bed at each sample location (see map on pg 2 of this calculation)

Calculate rating tables and curves for each cross section using FlowMaster PE (Haestad Methods, 1998). For flows within the channel banks, use Manning's "n" calculated based on field measurements:

Station	Q (cfs)	A (ft ²)	Avg. V (ft/s)	WP (ft)	R (ft)	S (ft/ft)	n
MC-4	13.69	5.6	2.4	12.05	0.46	0.007	0.031
MC-5	1.29	1.1	1.2	5.7	0.19	0.0157	0.053
MC-6	-	-	-	-	-	-	-

For MC-6, as no flow measurements were taken, an average Manning's 'n' of 0.031 was used to approximate the channel conditions. This value was selected based on site conditions and professional judgement.

For flows outside of the channel banks, use a Manning's "n" of 0.060 (typical of vegetated flood plains).

Rating tables and curves for each of the three Mud Creek cross sections are provided on pages 3-6 of this calculation. Cross sections are presented in Appendix E of this report. Water surface plots are shown on pages 7-9. Allowable velocities were determined for flows within the channel banks at discharge rates of 5,000 gpm (11.1 cfs), 10,000 gpm (22.3 cfs), 20,000 gpm (44.6 cfs), and 30,000 gpm (66.9 cfs). As the flow depths never exceeded the channel banks, no flood plain evaluation was conducted.

Channel bed results - see pp 10-11 of this calculation. All velocities at the design discharge rates are less than the allowable velocities. Hence, the channels will be erosional stable.

Channel bank results - see pg 13 of this calculation. All velocities at the design discharge rates are less than the allowable velocities. Hence, the channel banks will be erosional stable during the design discharges.

Rating Table and Discharge Curve for MC-4

Project Description

Worksheet MC-4
Flow Element Irregular Channel
Method Manning's
Formula
Solve For Channel Depth

Input Data

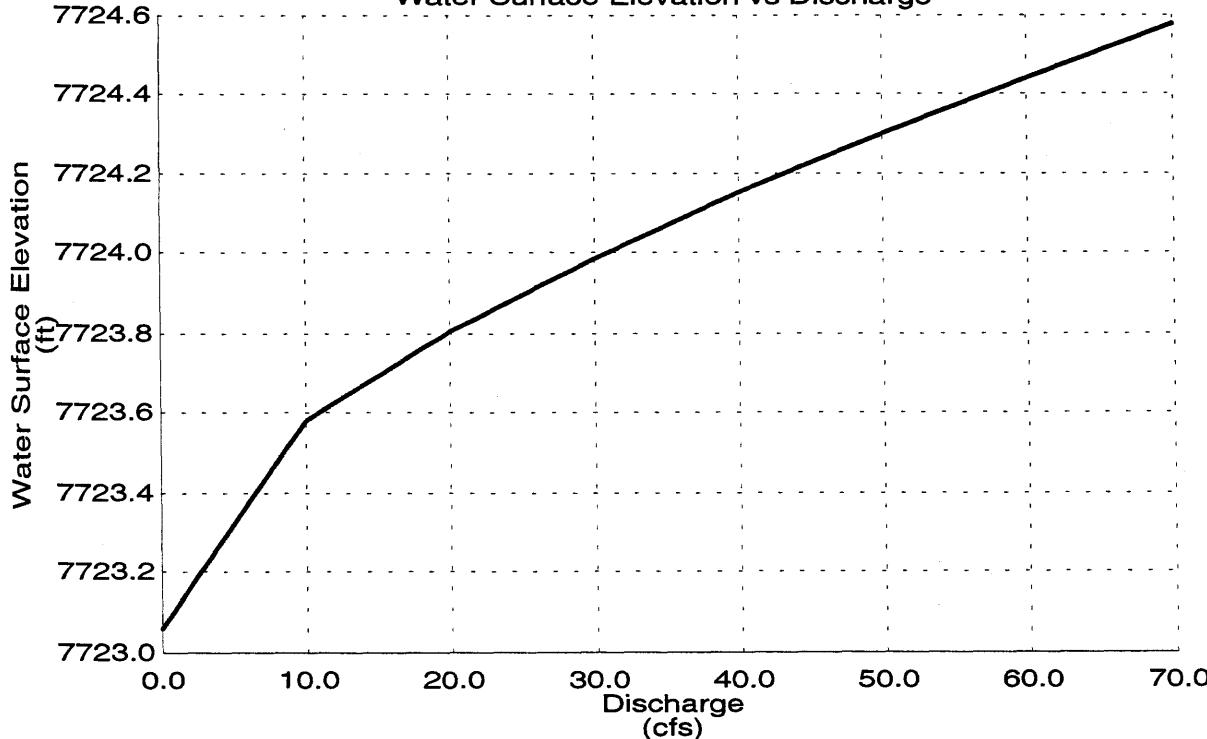
Slope 0.007000 ft/ft

Options

Current Roughness Method Improved Lotter's Method
Open Channel Weighting Method Improved Lotter's Method
Closed Channel Weighting Horton's Method
Method

Discharge (cfs)	Water Surface Elevation (ft)	Velocity (ft/s)	Flow Area (ft ²)	Wetted Perimeter (ft)	Top Width (ft)
10.00	7,723.58	2.17	4.6	11.83	11.52
20.00	7,723.80	2.78	7.2	12.38	11.80
30.00	7,723.99	3.20	9.4	12.83	12.03
40.00	7,724.15	3.51	11.4	13.23	12.24
50.00	7,724.30	3.77	13.2	13.60	12.43
60.00	7,724.44	4.00	15.0	13.95	12.61
70.00	7,724.57	4.19	16.7	14.27	12.78

Worksheet: MC-4
Water Surface Elevation vs Discharge



Rating Table and Discharge Curve for MC-5

Project Description

Worksheet MC-5
Flow Element Irregular Channel
Method Manning's
Solve For Formula
Channel Depth

Input Data

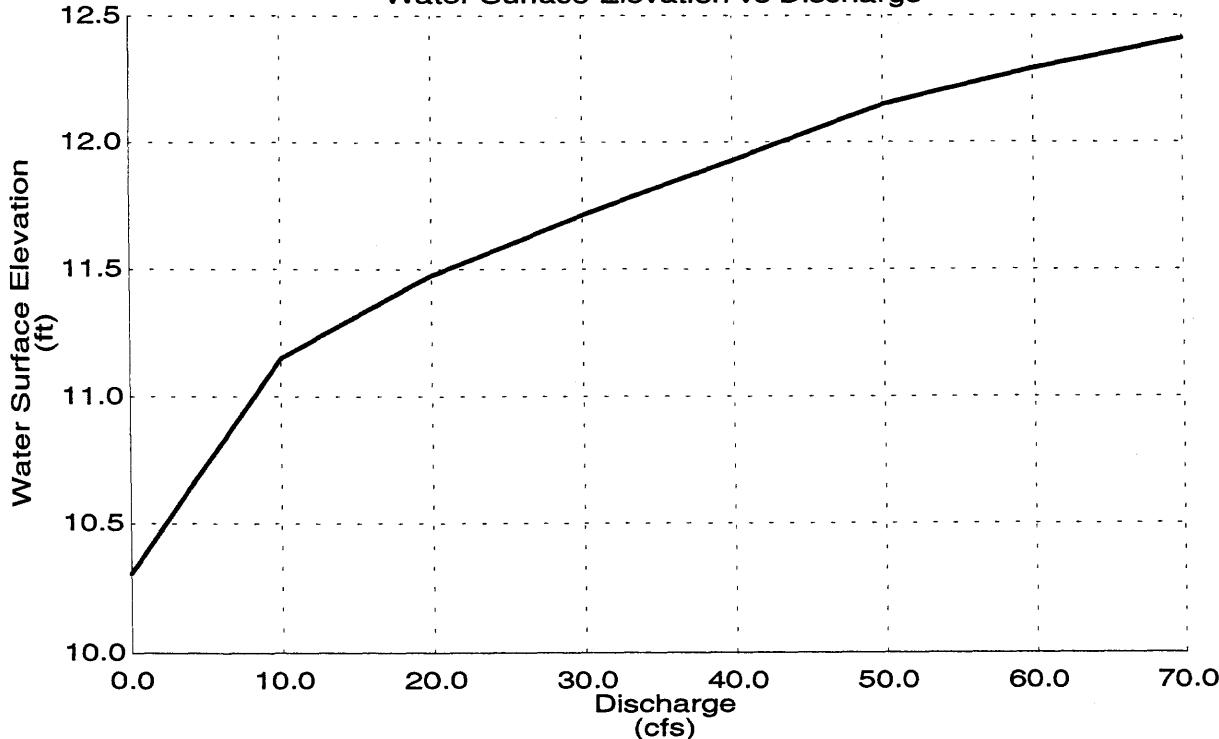
Slope 0.015700 ft/ft

Options

Current Roughness Method Improved Lotter's Method
Open Channel Weighting Method Improved Lotter's Method
Closed Channel Weighting Horton's Method
Method

Discharge (cfs)	Water Surface Elevation (ft)	Velocity (ft/s)	Flow Area (ft ²)	Wetted Perimeter (ft)	Top Width (ft)
0.00	10.30	0.00	0.0	0.00	0.00
10.00	11.15	2.25	4.4	8.65	8.06
20.00	11.47	2.74	7.3	10.64	9.72
30.00	11.72	3.05	9.8	12.16	11.02
40.00	11.92	3.27	12.2	13.43	12.18
50.00	12.15	3.28	15.2	16.15	14.77
60.00	12.29	3.44	17.4	17.09	15.61
70.00	12.41	3.63	19.3	17.42	15.84

Worksheet: MC-5
Water Surface Elevation vs Discharge



Rating Table and Discharge Curve for MC-6

Project Description

Worksheet MC-6
Flow Element Irregular Channel
Method Manning's
Formula
Solve For Channel Depth

Input Data

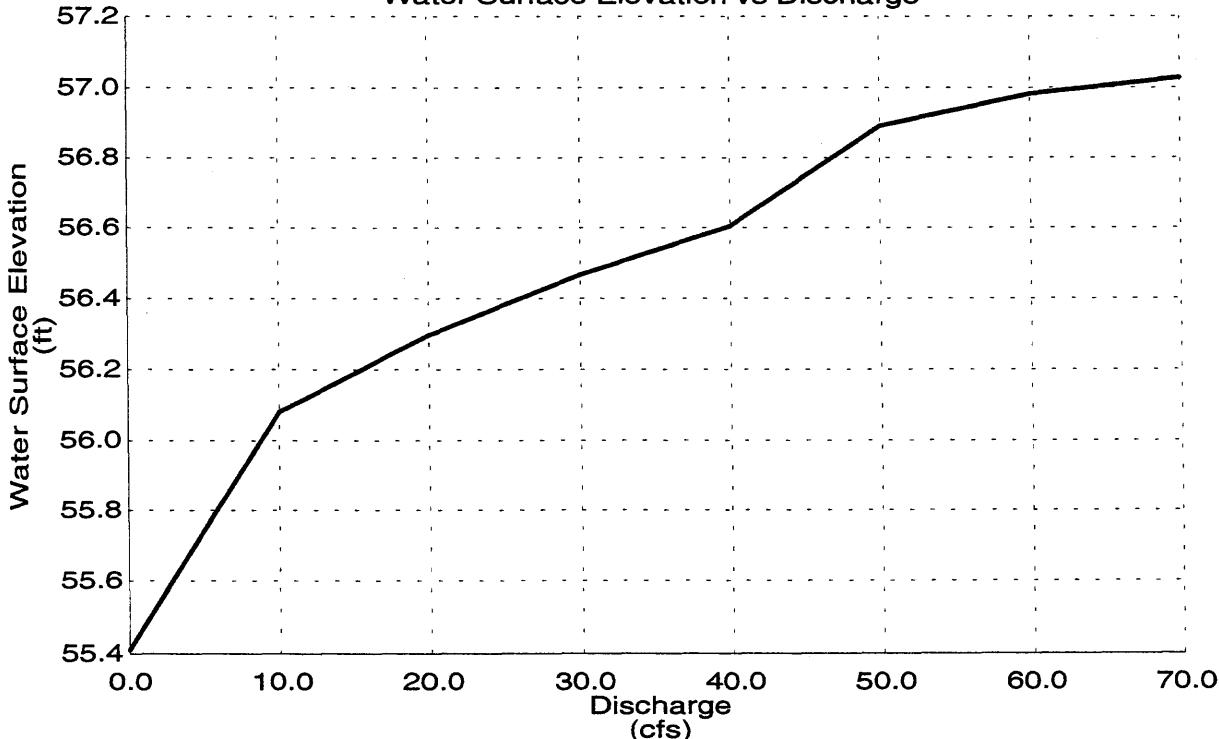
Slope 0.008700 ft/ft

Options

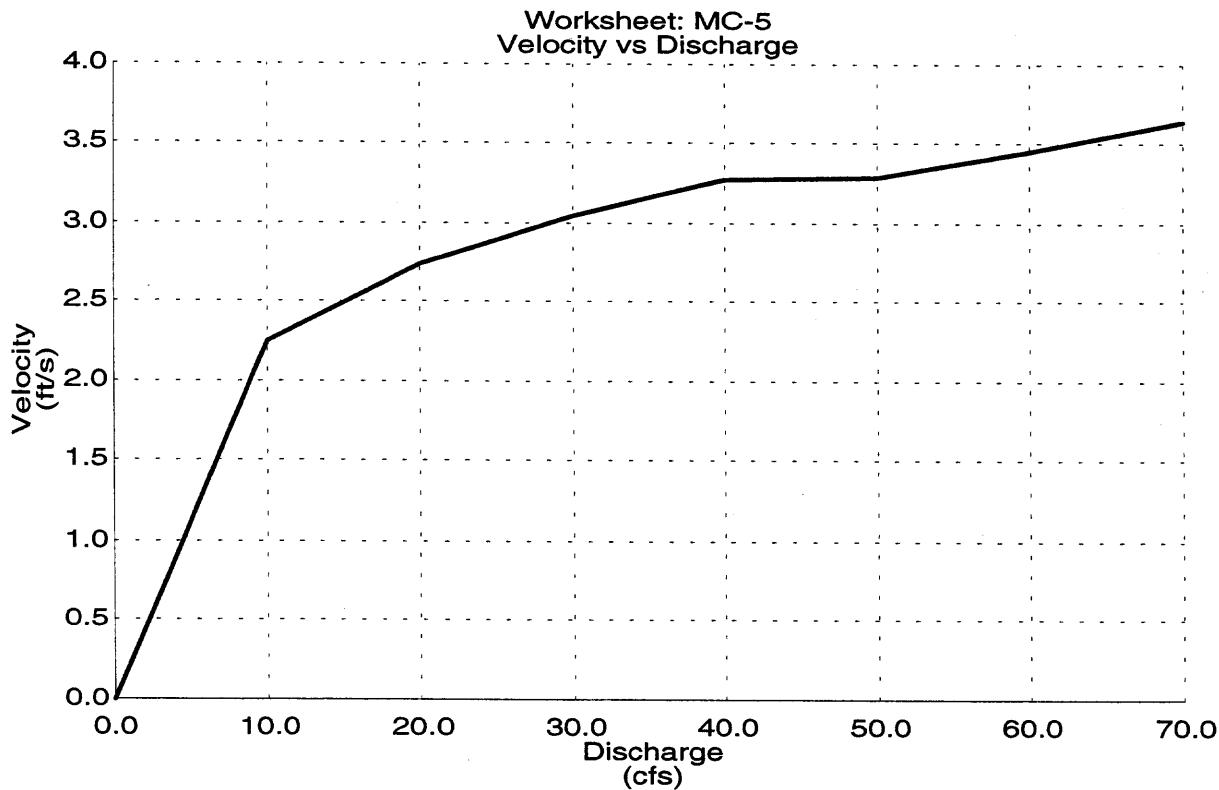
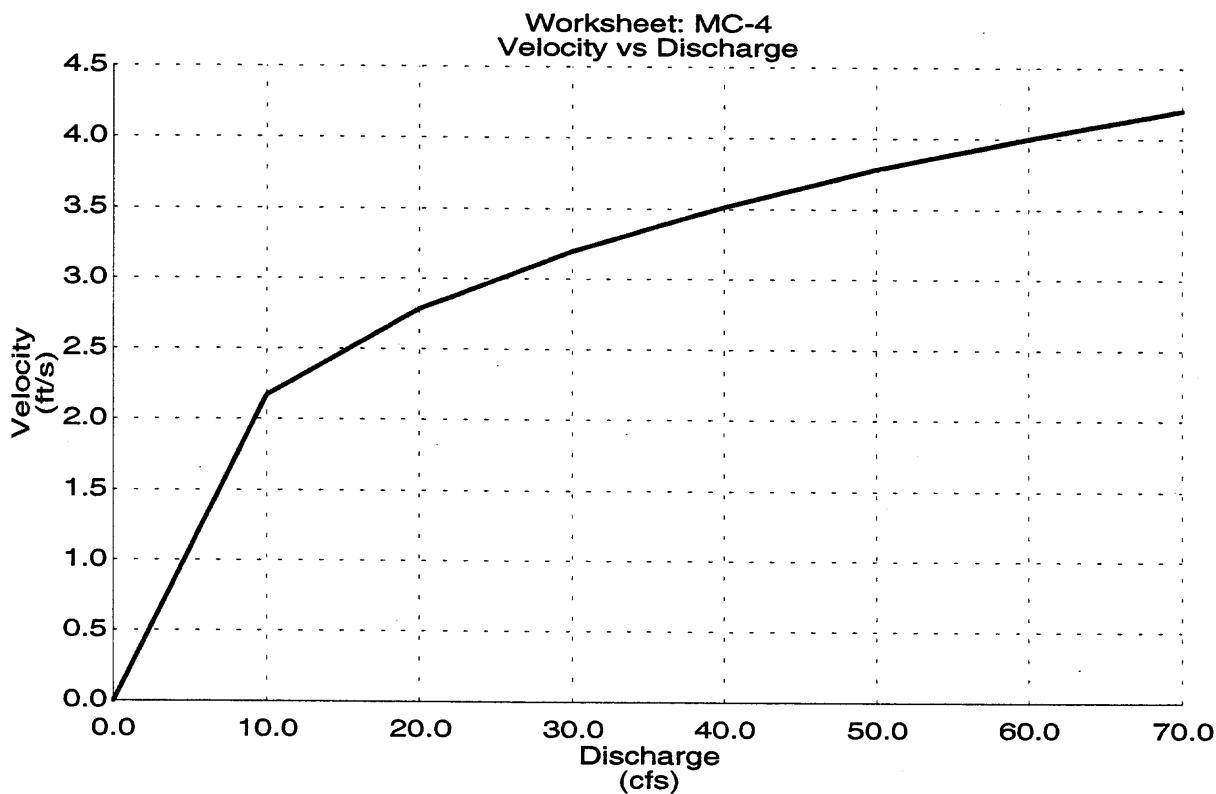
Current Roughness Method Improved Lotter's Method
Open Channel Weighting Method Improved Lotter's Method
Closed Channel Weighting Horton's Method
Method

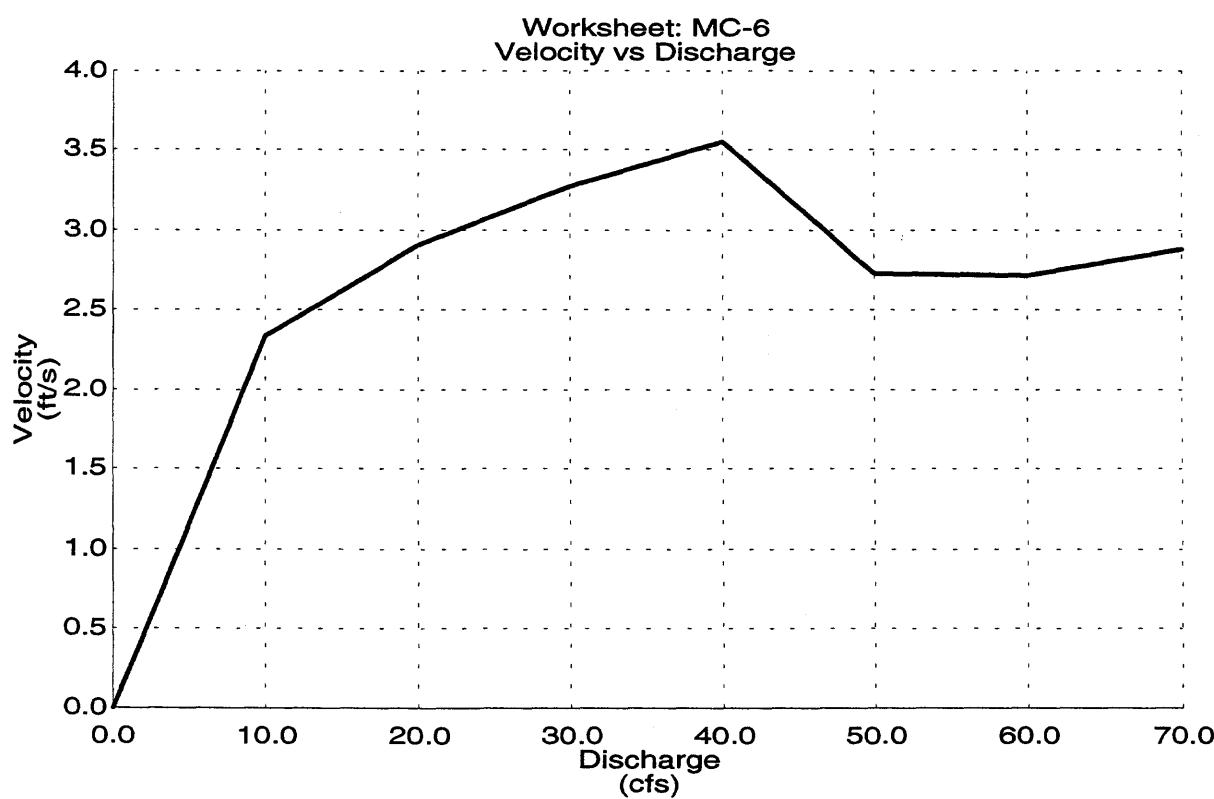
Discharge (cfs)	Water Surface Elevation (ft)	Velocity (ft/s)	Flow Area (ft ²)	Wetted Perimeter (ft)	Top Width (ft)
0.00	55.41	0.00	0.0	0.00	0.00
10.00	56.08	2.34	4.3	11.29	11.08
20.00	56.30	2.90	6.9	13.19	12.88
30.00	56.47	3.27	9.2	14.64	14.27
40.00	56.61	3.56	11.2	15.86	15.42
50.00	56.89	2.72	18.3	38.56	37.94
60.00	56.98	2.71	22.1	46.90	46.21
70.00	57.03	2.88	24.3	47.19	46.48

Worksheet: MC-6
Water Surface Elevation vs Discharge



Velocity Rating Curves for all Stations:





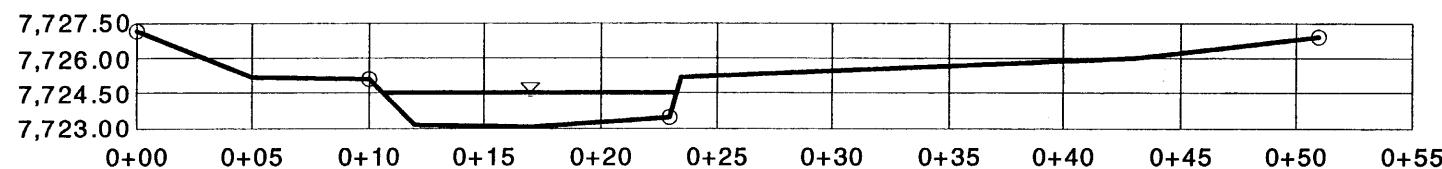
Cross Section
Cross Section for Irregular Channel

Project Description

Worksheet	MC-4
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Channel Depth

Section Data

Mannings Coefficient	0.033
Slope	0.007000 ft/ft
Water Surface Elevation	7,724.53 ft
Elevation Range	7,723.06 to 7,727.15
Discharge	66.90 cfs



V:1
H:1
NTS

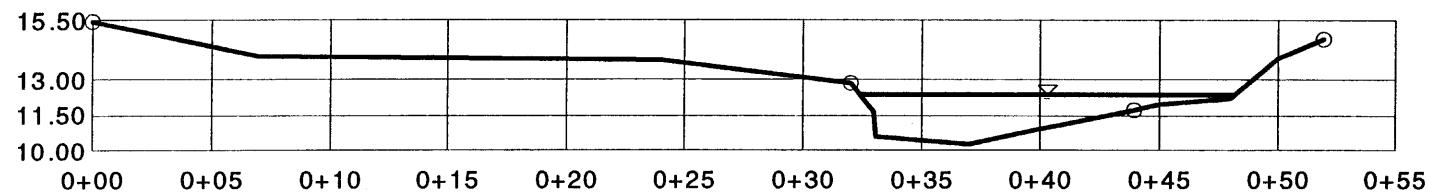
Cross Section
Cross Section for Irregular Channel

Project Description

Worksheet	MC-5
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Channel Depth

Section Data

Mannings Coefficient	0.055
Slope	0.015700 ft/ft
Water Surface Elevation	12.37 ft
Elevation Range	10.30 to 15.45
Discharge	66.90 cfs



V:1 ▲
H:1
NTS

Cross Section

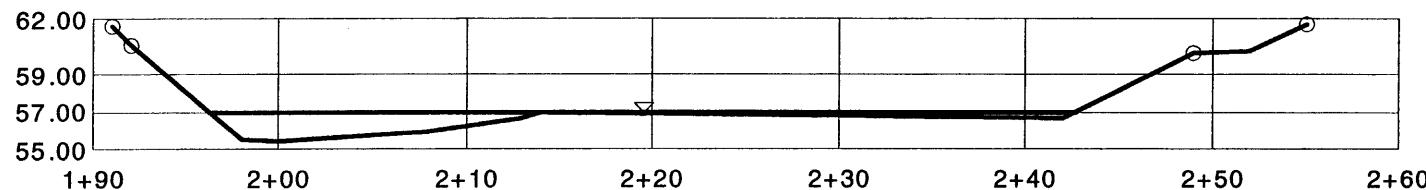
Cross Section for Irregular Channel

Project Description

Worksheet MC-6
Flow Element Irregular Channel
Method Manning's Formula
Solve For Channel Depth

Section Data

Mannings Coefficient 0.031
Slope 0.008700 ft/ft
Water Surface Elevation 57.01 ft
Elevation Range 55.41 to 61.73
Discharge 66.90 cfs



V:1 ▲
H:1
NTS

Allowable velocities on the channel bottom (i.e., no bank slope correction factor needed):

Stream Station	D ₇₅ (mm) ^(a)	Sediment-Laden Conditions ^(b)				Sediment-Free Conditions ^(b)				Actual Velocity (ft/s) ^(c)	Comments
		Basic Vel. (ft/s)	Depth Factor	Alignment Factor	Allowable Vel. (ft/s)	Basic Vel. (ft/s)	Depth Factor	Alignment Factor	Allowable Vel. (ft/s)		
Discharge Rate = 5,000 gpm (11.1 cfs)											
MC-4	49	8.2	0.9	1.0	7.4	5.9	0.9	1.0	5.3	2.3	OK
MC-5	94	10.7	0.9	1.0	9.6	8.3	0.9	1.0	7.5	2.3	OK
MC-6	119	11.1	0.9	1.0	10.0	9.0	0.9	1.0	8.1	2.4	OK
Discharge Rate = 10,000 gpm (22.3 cfs)											
MC-4	49	8.2	0.9	1.0	7.4	5.9	0.9	1.0	5.3	2.9	OK
MC-5	94	10.7	0.9	1.0	9.6	8.3	0.9	1.0	7.5	2.8	OK
MC-6	119	11.1	0.9	1.0	10.0	9.0	0.9	1.0	8.1	3.0	OK

(a) See gradation results (pp. 12 of this calculation)

(b) See graphs on pg. 13 of this calculation

(c) See velocity rating curves (pp.5-6 of this calculation)

Allowable velocities on the channel bottom (continued):

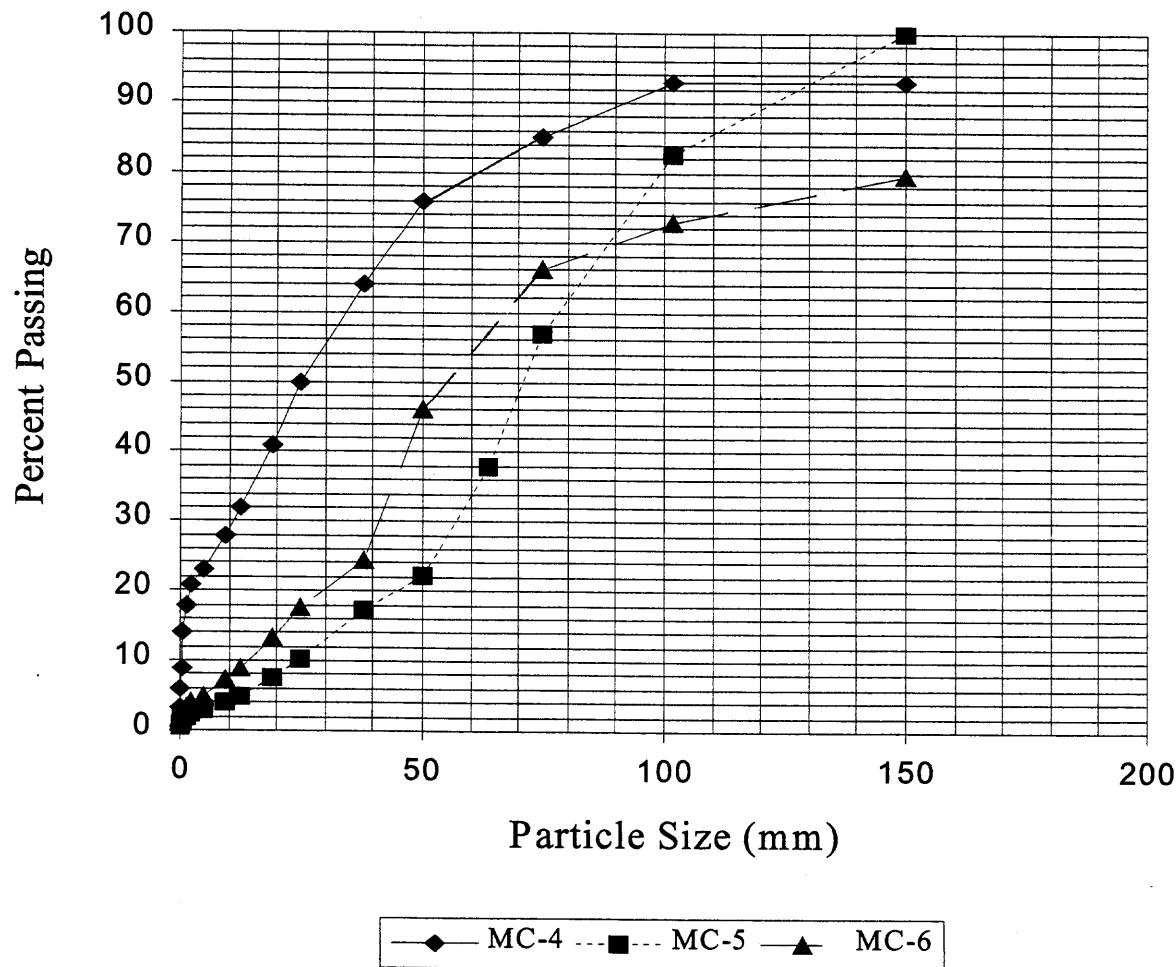
Stream Station	D ₇₅ (mm) ^(a)	Sediment-Laden Conditions ^(b)				Sediment-Free Conditions ^(b)				Actual Velocity (ft/s) ^(c)	Comments
		Basic Vel. (ft/s)	Depth Factor	Alignment Factor	Allowable Vel. (ft/s)	Basic Vel. (ft/s)	Depth Factor	Alignment Factor	Allowable Vel. (ft/s)		
Discharge Rate = 20,000 gpm (44.6 cfs)											
MC-4	49	8.2	0.9	1.0	7.4	5.9	0.9	1.0	5.3	3.6	OK
MC-5	94	10.7	0.9	1.0	9.6	8.3	0.9	1.0	7.5	3.3	OK
MC-6	119	11.1	0.9	1.0	10.0	9.0	0.9	1.0	8.1	2.8	OK
Discharge Rate = 30,000 gpm (66.9 cfs)											
MC-4	49	8.2	0.9	1.0	7.4	5.9	0.9	1.0	5.3	4.1	OK
MC-5	94	10.7	0.9	1.0	9.6	8.3	0.9	1.0	7.5	3.6	OK
MC-6	119	11.1	0.9	1.0	10.0	9.0	0.9	1.0	8.1	2.8	OK

(a) See gradation results (pp. 12 of this calculation)

(b) See graphs on pg. 15 of this calculation

(c) See velocity rating curves (pp.5-6 of this calculation)

Mud Creek Bed Gradations



<u>MC-4</u>	<u>MC-5</u>	<u>MC-6</u>
$D_{10} = 0.32$	$D_{10} = 24$	$D_{10} = 14$
$D_{30} = 11$	$D_{30} = 57$	$D_{30} = 41$
$D_{60} = 34$	$D_{60} = 78$	$D_{60} = 67$
$C_v = D_{60}/D_{10} = 106 > 4$	$C_v = 3.2 < 4 \Rightarrow GP$	$C_v = 4.8 > 4 \quad \left. \begin{array}{l} C_z = 1.8 \\ \end{array} \right\} \Rightarrow GW$
$C_z = \frac{D_{30}^2}{D_{10}D_{60}} = 11 > 3 \Rightarrow GP$		

Calculate allowable velocities on channel banks. Channel banks below the grass line are comprised of material typical of the bed materials. Therefore, base the analysis on the vegetated portion of the channel banks (i.e., gravelly soil). The vegetation consists of a good stand of native grasses, approx 12" tall. Evaluate each cross section at its maximum velocity. Assume the average cross section velocity is representative of the velocity against the bank. Soils are erosion resistant:

Stream Station	Bank Soil Type ^(a)	Channel Slope (%)	Allowable Vel. (ft/s) ^(b)	Max. Actual Vel. (ft/s) ^(c)	Comments
MC-4	GP	0.7	7	4.1	OK
MC-5	GP	1.6	7	3.6	OK
MC-6	GW	0.9	7	2.8	OK

(a) See gradation results (pp. 12 of this calculation)

(b) See table on pg 14 of this calculation

(c) Maximum velocity of flow \leq 30,000 gpm from velocity rating curves (pp. 8 of this calc.)

Allowable Velocities for Vegetated Channels
(From Haan et al., 1994)

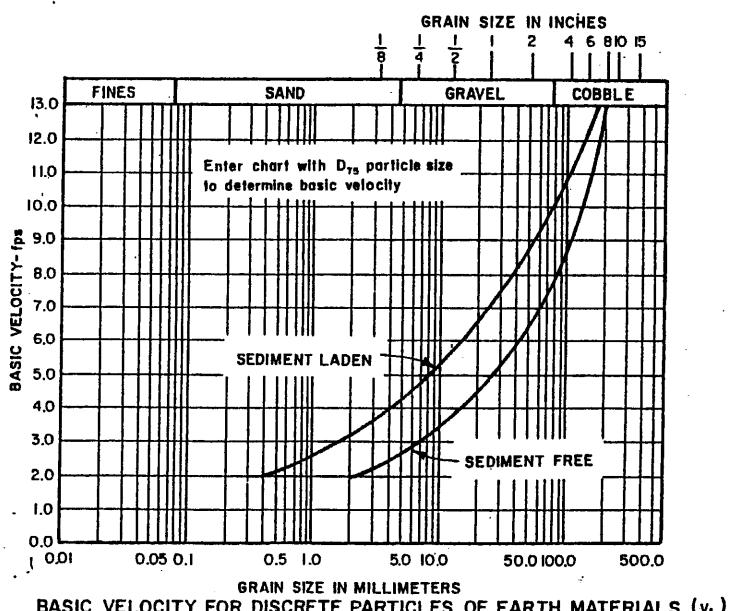
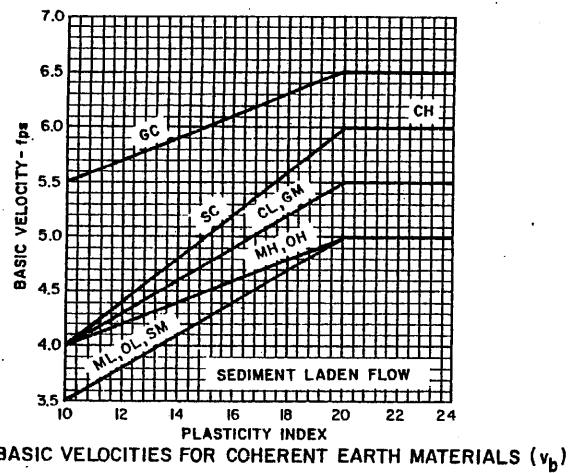
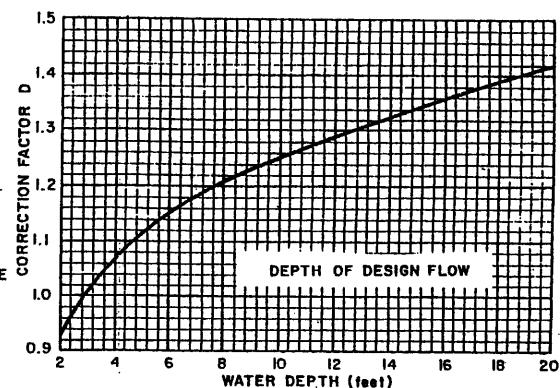
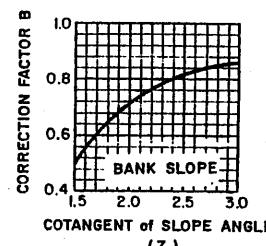
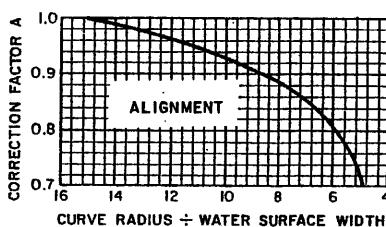
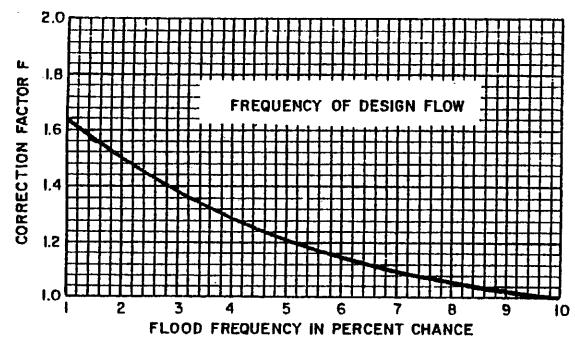
	Allowable Velocity (ft/s)					
	Erosion-Resistant Soils (% Slope)			Easily Eroded Soils (% Slope)		
	0-5	5-10	>10	0-5	5-10	>10
Bermuda grass	8	7	6	6	5	4
Buffalo grass Kentucky bluegrass Smooth brome Blue gramma Tall fescue	7	6	5	5	4	3
Lespedeza sericea Weeping lovegrass Kudzu Alfalfa Crabgrass	3.5	NR ^(a)	NR	2.5	NR	NR
Grass mixture	5	4	NR	4	3	NR
Annuals for temporary protection	3.5	NR	NR	2.5	NR	NR

^(a) Not recommended

Note: Shaded row considered representative of natural grasses along Mud Creek.

References Cited

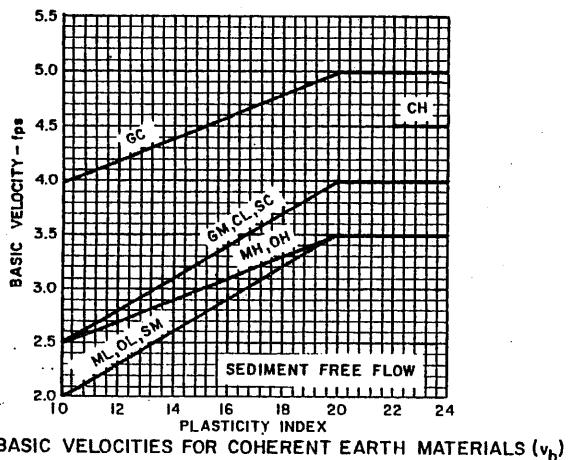
- Haan, C.T., B.J. Barfield, and J.C. Hayes. 1994. Design Hydrology and Sedimentology for Small Catchments. Academic Press. San Diego, CA.
- Haestad Methods, Inc. 1998. FlowMaster Professional Edition for Windows, Version 6.0. Waterbury, CT.
- U.S. Soil Conservation Service. 1977. Design of Open Channels. Technical Release No. 25. U.S. Department of Agriculture. Washington, D.C.



NOTES:

- In no case should the allowable velocity be exceeded when the 10% chance discharge occurs, regardless of the design flow frequency.

Source: US SCS (1977)



ALLOWABLE VELOCITIES FOR UNPROTECTED EARTH CHANNELS	
CHANNEL BOUNDARY MATERIALS	ALLOWABLE VELOCITY
DISCRETE PARTICLES	
Sediment Laden Flow	
$D_{75} > 0.4 \text{ mm}$	Basic velocity chart value $\times D \times A \times B$
$D_{75} < 0.4 \text{ mm}$	2.0 fps
Sediment Free Flow	
$D_{75} > 2.0 \text{ mm}$	Basic velocity chart value $\times D \times A \times B$
$D_{75} < 2.0 \text{ mm}$	2.0 fps
COHERENT EARTH MATERIALS	
$PI > 10$	Basic velocity chart value $\times D \times A \times F \times C_e$
$PI < 10$	2.0 fps

ALLOWABLE VELOCITIES
FOR UNPROTECTED EARTH CHANNELS

Revised -

Canyon Fuel Company
Skyline Mine

Mine-Water Discharge Impact
December 2002

APPENDIX I

Geotechnical Stability Analyses

RESULTS OF SLOPE STABILITY ANALYSES MUD CREEK SECTIONS MC-4, MC-5, AND MC-6

Following are cross-sections and results of slope stability analyses for Mud Creek at Sections MC-4, MC-5, and MC-6. The following assumptions were made for these analyses:

1. Results of direct shear tests on soil samples collected from the channel bank were used for the analyses. Soil property parameters used in the evaluation are summarized in Table 1 of this appendix.
2. The soils drain rapidly, and excess pore pressures do not develop in response to strains and stress changes.
3. The steepest slope was analyzed at each section.

Slope stability analyses were performed using the computer program GEOSLOPE (Version 5.0). GEOSLOPE utilizes the limit equilibrium procedure of slices (Simplified Bishop's method) to determine the safety factor of potential failure surfaces for circular shapes.

Using the assumptions presented above, the results of the slope stability analyses are attached and summarized in Table 1 of this appendix. The results of the analyses include cross-sections with the critical failure surface, the data files, and the output files. Table 1 includes the number of trial failure surfaces and the critical safety factors against slope failure.

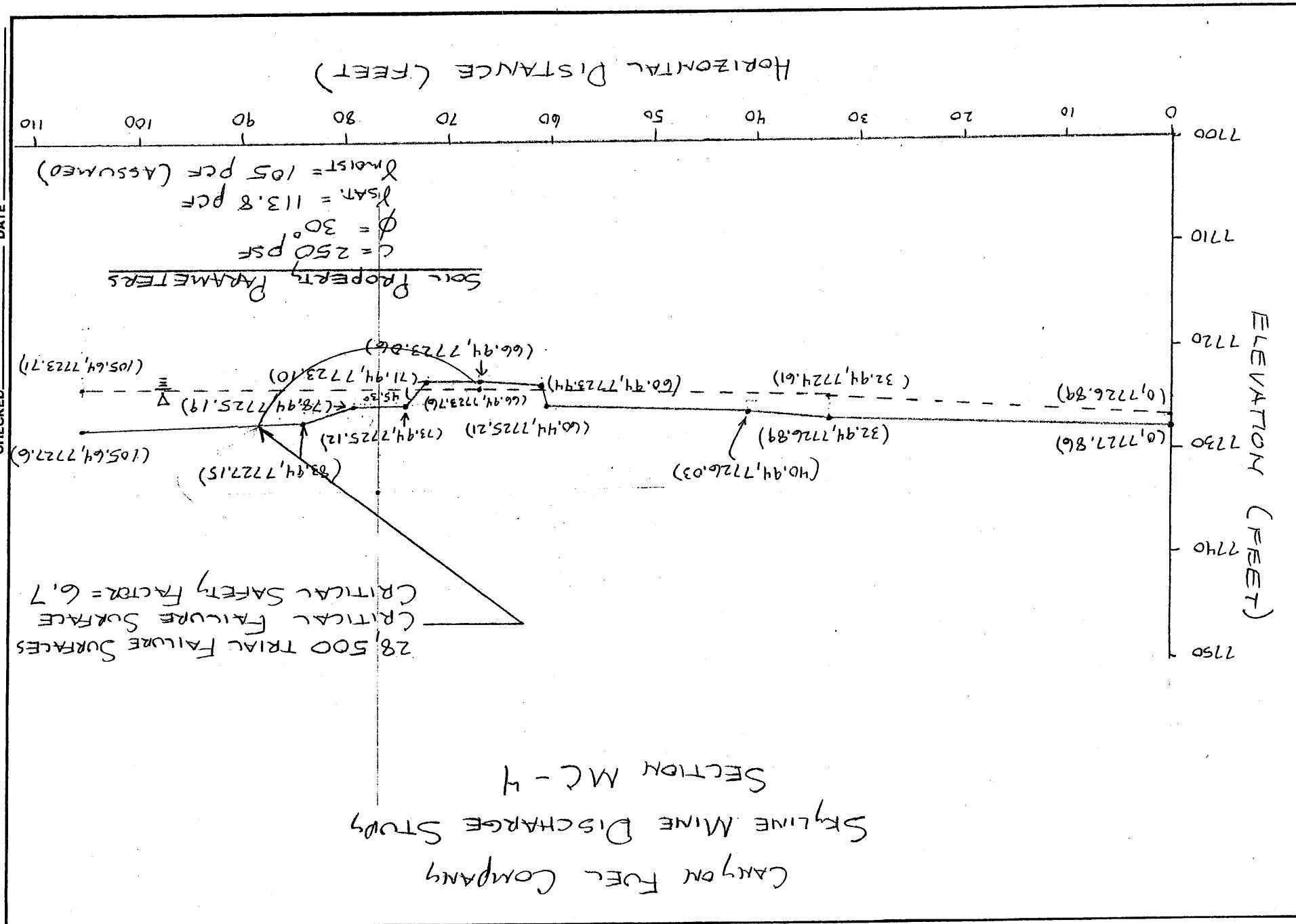
TABLE 1

SOIL PROPERTY PARAMETERS AND RESULTS OF SLOPE STABILITY ANALYSES

Section	Direct Shear Test Values		Number of Trial Failure Surfaces	Safety Factor
	Cohesive Strength (psf)	Angle of Internal Friction (degrees)		
MC-4	250	30	28,500	6.7
MC-5	80	33.5	14,200	2.8
MC-6	90	39	24,200	2.5

EARTHFAK ENGINEERING, INC.
ENGINEERS / SCIENTISTS

PROJECT DC 94.03 PAGE 1 OF 1
COMPUTED RKB DATE 1/7/03



TITLE

SKYLINE MINES DISCHARGE STUDY
MUD CREEK CROSS SECTION MC-4
MEASURED WATER LEVEL; MC4.DAT

PROFIL

10 10

0 7727.86 32.94 7726.89 1
32.94 7726.89 40.94 7726.03 1
40.94 7726.03 60.44 7725.21 1
60.44 7725.21 60.94 7723.44 1
60.94 7723.44 66.94 7723.06 1
66.94 7723.06 71.94 7723.1 1
71.94 7723.1 73.94 7725.12 1
73.94 7725.12 78.94 7725.19 1
78.94 7725.19 83.94 7727.15 1
83.94 7727.15 105.64 7727.6 1

SOIL

1

105 113.8 250 30 0 0 1

WATER

1 62.4

4

0 7726.89
32.94 7724.61
66.94 7723.76
105.64 7723.71

CIRCL2

95 300 63 72.5 73.94 95 7700 1 40 -45

END

GeoSlope
Version 5.00

(c)1992 by GEOCOMP Corp, Concord, MA
Licensed to EarthFax Engineering

Problem Title: SKYLINE MINES DISCHARGE STUDY
Description: MUD CREEK CROSS SECTION MC-4
Remarks: MEASURED WATER LEVEL; MC4.DAT

INPUT DATA

Profile Boundaries

Number of Boundaries: 10
Number of Top Boundaries: 10

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	0.00	7727.86	32.94	7726.89	1
2	32.94	7726.89	40.94	7726.03	1
3	40.94	7726.03	60.44	7725.21	1
4	60.44	7725.21	60.94	7723.44	1
5	60.94	7723.44	66.94	7723.06	1
6	66.94	7723.06	71.94	7723.10	1
7	71.94	7723.10	73.94	7725.12	1
8	73.94	7725.12	78.94	7725.19	1
9	78.94	7725.19	83.94	7727.15	1
10	83.94	7727.15	105.64	7727.60	1

Soil Parameters

Number of Soil Types: 1

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	105.0	113.8	250.0	30.0	0.00	0.0	1

Piezometric Surfaces

Number of Surfaces: 1
Unit Weight of Water: 62.40 pcf

Piezometric Surface No.: 1
Number of Coordinate Points: 4

Point No.	X-Water (ft)	Y-Water (ft)
1	0.00	7726.89
2	32.94	7724.61
3	66.94	7723.76
4	105.64	7723.71

***** TRIAL SURFACE GENERATION *****

Data for Generating Circular Surfaces

Number of Initiation Points: 95
Number of Surfaces From Each Point: 300
Left Initiation Point: 63.00 ft
Right Initiation Point: 72.50 ft
Left Termination Point: 73.94 ft
Right Termination Point: 95.00 ft
Minimum Elevation: 7700.00 ft
Segment Length: 1.00 ft
Positive Angle Limit: 40.00 deg
Negative Angle Limit: -45.00 deg

RESULTS

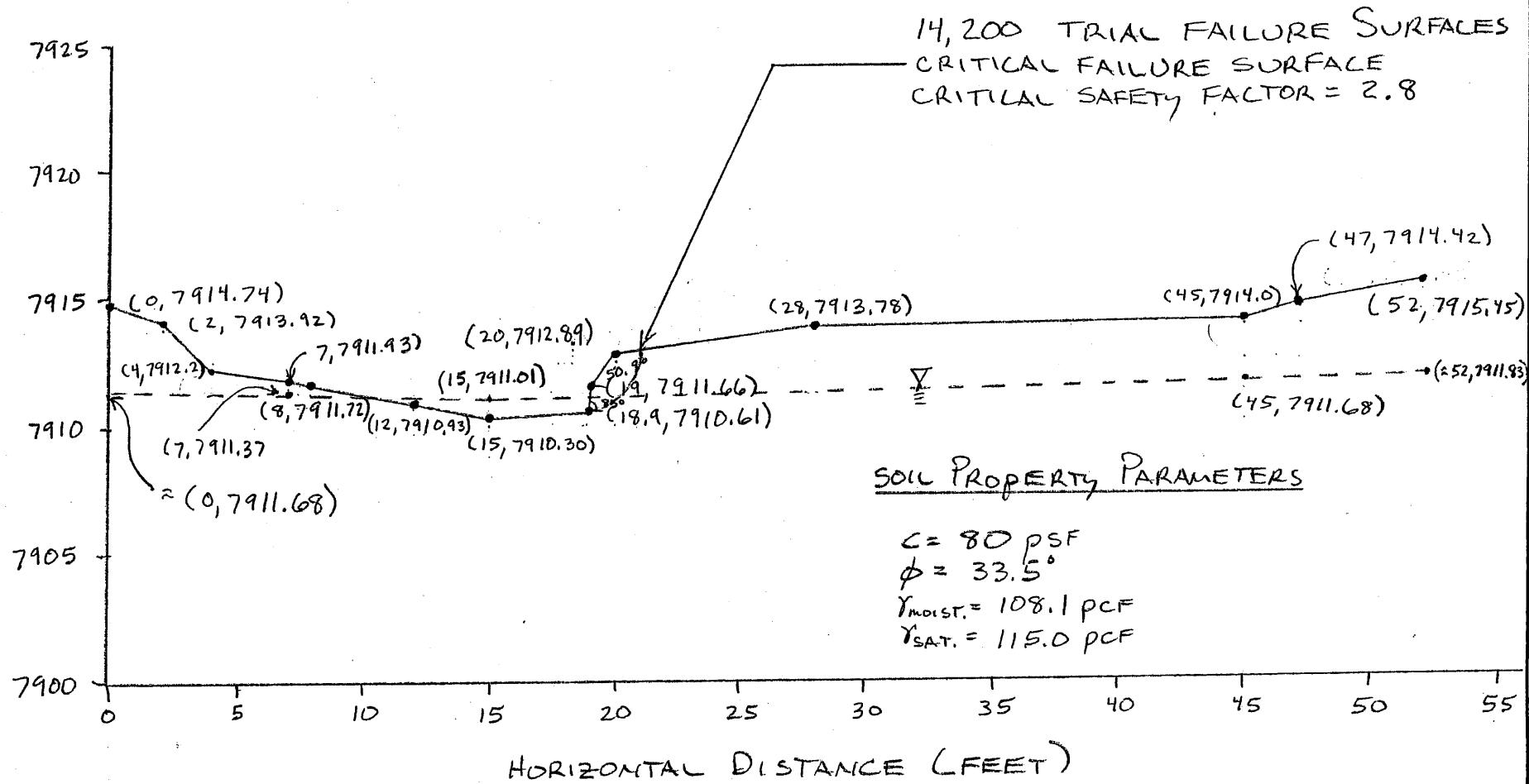
Critical Surfaces

No.	Safety Factor	Center X (ft)	Center Y (ft)	Circle Radius (ft)
1	6.774	76.73	7733.52	14.33
2	6.774	76.59	7733.83	14.98
3	6.777	76.34	7733.48	14.55
4	6.778	76.36	7733.99	14.93
5	6.778	76.52	7733.93	14.55
6	6.779	76.87	7733.12	14.06
7	6.782	76.43	7734.83	15.67
8	6.783	76.83	7733.63	14.93
9	6.784	76.63	7733.10	14.42
10	6.784	76.79	7734.62	15.68

EARTHFAX ENGINEERING, INC.
ENGINEERS / SCIENTISTS

PROJECT UC794.03 PAGE 1 OF 1
COMPUTED RKB DATE 1/16/03

CANYON FUEL COMPANY
SKYLINE MINE DISCHARGE STUDY
SECTION MC - 5



TITLE

SKYLINE MINES DISCHARGE STUDY
MUD CREEK CROSS SECTION MC-5
MEASURED WATER LEVEL; MC5.DAT

PROFIL

13 13

0 7914.74 2 7913.92 1
2 7913.92 4 7912.2 1
4 7912.2 7 7911.93 1
7 7911.93 8 7911.72 1
8 7911.72 12 7910.93 1
12 7910.93 15 7910.3 1
15 7910.3 18.9 7910.61 1
18.9 7910.61 19 7911.66 1
19 7911.66 20 7912.89 1
20 7912.89 28 7913.78 1
28 7913.78 45 7914 1
45 7914 47 7914.42 1
47 7914.42 52 7915.45 1

SOIL

1

108.1 115 80 33.5 0 0 1

WATER

1 62.4

5

0 7911.68
7 7911.37
15 7911.01
45 7911.68
52 7911.83

CIRCL2

71 200 12 18.95 19.5 30 7900 1 80 -45

END

GeoSlope
Version 5.00

(c)1992 by GEOCOMP Corp, Concord, MA
Licensed to EarthFax Engineering

Problem Title: SKYLINE MINES DISCHARGE STUDY
Description: MUD CREEK CROSS SECTION MC-5
Remarks: MEASURED WATER LEVEL; MC5.DAT

***** INPUT DATA *****

Profile Boundaries

Number of Boundaries: 13
Number of Top Boundaries: 13

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	0.00	7914.74	2.00	7913.92	1
2	2.00	7913.92	4.00	7912.20	1
3	4.00	7912.20	7.00	7911.93	1
4	7.00	7911.93	8.00	7911.72	1
5	8.00	7911.72	12.00	7910.93	1
6	12.00	7910.93	15.00	7910.30	1
7	15.00	7910.30	18.90	7910.61	1
8	18.90	7910.61	19.00	7911.66	1
9	19.00	7911.66	20.00	7912.89	1
10	20.00	7912.89	28.00	7913.78	1
11	28.00	7913.78	45.00	7914.00	1
12	45.00	7914.00	47.00	7914.42	1
13	47.00	7914.42	52.00	7915.45	1

Soil Parameters

Number of Soil Types: 1

Soil Type	Total Unit Wt.	Saturated Unit Wt.	Cohesion Intercept	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
No.	(pcf)	(pcf)	(psf)	(deg)			
1	108.1	115.0	80.0	33.5	0.00	0.0	1

Piezometric Surfaces

Number of Surfaces: 1
Unit Weight of Water: 62.40 pcf

Piezometric Surface No.: 1
Number of Coordinate Points: 5

Point No.	X-Water (ft)	Y-Water (ft)
1	0.00	7911.68
2	7.00	7911.37
3	15.00	7911.01
4	45.00	7911.68
5	52.00	7911.83

***** TRIAL SURFACE GENERATION *****

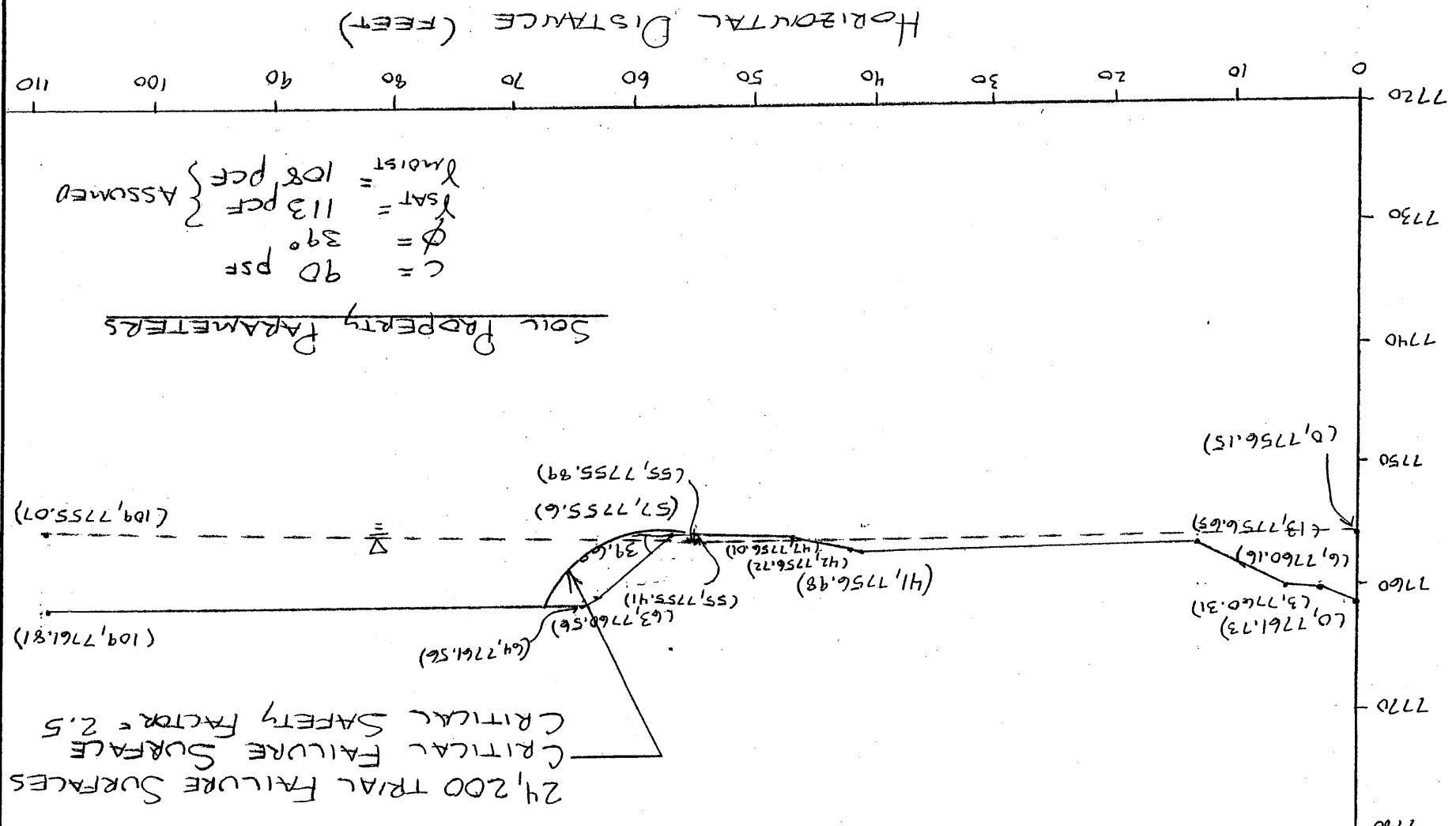
Data for Generating Circular Surfaces

Number of Initiation Points:	71
Number of Surfaces From Each Point:	200
Left Initiation Point:	12.00 ft
Right Initiation Point:	18.95 ft
Left Termination Point:	19.50 ft
Right Termination Point:	30.00 ft
Minimum Elevation:	7900.00 ft
Segment Length:	1.00 ft
Positive Angle Limit:	80.00 deg
Negative Angle Limit:	-45.00 deg

RESULTS

Critical Surfaces

No.	Safety Factor	Center X (ft)	Center Y (ft)	Circle Radius (ft)
1	2.859	18.34	7913.23	2.75
2	2.861	18.72	7912.72	2.36
3	2.862	18.48	7914.10	3.57
4	2.878	18.25	7913.45	2.94
5	2.879	18.40	7913.41	2.94
6	2.884	18.37	7913.54	3.06
7	2.907	18.69	7913.90	3.42
8	2.909	18.61	7913.66	3.22
9	2.911	18.71	7912.88	2.50
10	2.915	18.48	7912.97	2.56



TITLE

SKYLINE MINES DISCHARGE STUDY
MUD CREEK CROSS SECTION MC-6
MEASURED WATER LEVEL; MC6.DAT

PROFIL

11 11

0 7761.73 3 7760.31 1
3 7760.31 6 7760.16 1
6 7760.16 13 7756.65 1
13 7756.65 41 7756.98 1
41 7756.98 42 7756.72 1
42 7756.72 47 7756.01 1
47 7756.01 55 7755.41 1
55 7755.41 57 7755.6 1
57 7755.6 63 7760.56 1
63 7760.56 64 7761.56 1
64 7761.56 109 7761.81 1

SOIL

1

105 113 90 39 0 0 1

WATER

1 62.4

3

0 7756.15

55 7755.89

109 7755.07

CIRCL2

121 200 47 59 62.5 90 7730 2 35 -45

END

GeoSlope
Version 5.00

(c)1992 by GEOCOMP Corp, Concord, MA
Licensed to EarthFax Engineering

Problem Title: SKYLINE MINES DISCHARGE STUDY
Description: MUD CREEK CROSS SECTION MC-6
Remarks: MEASURED WATER LEVEL; MC6.DAT

INPUT DATA

Profile Boundaries

Number of Boundaries: 11
Number of Top Boundaries: 11

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	0.00	7761.73	3.00	7760.31	1
2	3.00	7760.31	6.00	7760.16	1
3	6.00	7760.16	13.00	7756.65	1
4	13.00	7756.65	41.00	7756.98	1
5	41.00	7756.98	42.00	7756.72	1
6	42.00	7756.72	47.00	7756.01	1
7	47.00	7756.01	55.00	7755.41	1
8	55.00	7755.41	57.00	7755.60	1
9	57.00	7755.60	63.00	7760.56	1
10	63.00	7760.56	64.00	7761.56	1
11	64.00	7761.56	109.00	7761.81	1

Soil Parameters

Number of Soil Types: 1

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	105.0	113.0	90.0	39.0	0.00	0.0	1

Piezometric Surfaces

Number of Surfaces: 1
Unit Weight of Water: 62.40 pcf

Piezometric Surface No.: 1
Number of Coordinate Points: 3

Point No.	X-Water (ft)	Y-Water (ft)
1	0.00	7756.15
2	55.00	7755.89
3	109.00	7755.07

**** * TRIAL SURFACE GENERATION * ****

Data for Generating Circular Surfaces

Number of Initiation Points:	121
Number of Surfaces From Each Point:	200
Left Initiation Point:	47.00 ft
Right Initiation Point:	59.00 ft
Left Termination Point:	62.50 ft
Right Termination Point:	90.00 ft
Minimum Elevation:	7730.00 ft
Segment Length:	2.00 ft
Positive Angle Limit:	35.00 deg
Negative Angle Limit:	-45.00 deg

RESULTS

Critical Surfaces

No.	Safety Factor	Center X (ft)	Center Y (ft)	Circle Radius (ft)
1	2.518	57.01	7764.94	9.36
2	2.519	57.30	7764.13	8.55
3	2.528	57.87	7764.41	8.85
4	2.529	57.23	7764.17	8.60
5	2.530	55.97	7766.33	10.77
6	2.531	57.99	7763.87	8.33
7	2.532	57.27	7764.04	8.47
8	2.533	57.61	7765.29	9.72
9	2.535	56.37	7765.30	9.72
10	2.536	57.42	7765.34	9.81